



EROSION AND SEDIMENT CONTROL MANUAL

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**City of Portland Oregon
Bureau of Development Services
Bureau of Environmental Services
Portland Office of Transportation
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1 INTRODUCTION

1.1 PURPOSE AND APPLICABILITY

This Erosion Control Manual provides technical guidance for temporary and permanent erosion prevention, sediment control, and control of other development activities that can cause pollution during the construction process (before, during, and after clearing, grubbing, grading, and excavation). The manual is in accordance with the City of Portland's Title 10 Erosion and Sediment Control Regulations.

Title 10 and this Erosion Control Manual apply to all ground-disturbing activities, whether or not a permit is required, unless such activities are otherwise exempted by Portland City Code.

Site planning and good site control are the best practices that can be used to prevent discharges from a development site. The manual emphasizes careful planning and erosion prevention over measures taken to control sediment and pollutants after the fact. Undisturbed groundcover must be retained whenever possible. This emphasis is particularly important in the Pacific Northwest immediately before and during the rainy season, when it is difficult to establish vegetation and the intense rains have high erosion potential.

1.2 PROBLEM STATEMENT

Erosion is the movement of soil and sediment, mainly by wind and water. Runoff from rain cuts rills and gullies, while wind can strip soil from wide areas. Both types of erosion can move large amounts of sediment, sometimes far from the original site of soil disturbance.

Four main factors influence erosion:

- **Soil erodibility:** Fine soils, impermeable soils, and soils lacking organic material tend to be more erodible.
- **Vegetative cover:** Vegetation shields soil from rainfall and wind, increases infiltration, slows runoff velocities, and retains soil moisture for later plant use between rainstorms.
- **Topography:** Long, steep slopes increase runoff amounts and velocities and therefore tend to increase erosion.
- **Weather:** The frequency, intensity, and duration of rainfall influence sediment release amounts.

Sediment from disturbed soils can move into neighboring properties, streets, drainage systems, and other bodies of water. Excessive sediment damages the functions of both stormwater sewers and natural watersheds.

Excess sediment is a problem for fish and other aquatic life. Construction site sediments are especially damaging for fish – such as local salmon – because the sediments are predominantly silts and clays. Sediment resulting from natural processes is usually coarser than construction site silts. While natural sediments are essential to the development and maintenance of instream habitat, excess silts and other fine sediments have many negative effects, including:

- Repelling migrating salmon from water with high sediment loads.
- Smothering and burying fish eggs and emerging juvenile fish.
- Filling in gravels that provide winter habitat for juvenile salmon.
- Changing streambed geometry and stream flow patterns, which disrupts fish habitat.
- Abrading and clogging of fish gills.
- Smothering or burying streambed insects and other food sources for fish.

The U.S. Environmental Protection Agency estimates that approximately 600 million tons of soil erodes from U.S. construction sites alone each year (1993). As the Portland metropolitan area continues to grow, ground disturbance is affecting local waterways. The greatest sediment impacts occur during the land grubbing, clearing, grading, and other excavation phases of development.

Left unchecked, excessive sediment can smother instream and near-stream habitat, raise streambeds, alter watercourses, reduce infiltration, and contribute to increased flooding. It also makes water muddy, interfering with recreational uses. Local governments and their taxpayers must pay to remove sediment from streets, sewers, ditches, sumps, and culverts and to dredge sediment from harbors and navigation channels. The implementation of adequate erosion control practices can reduce or avoid these problems.

1.3 HOW THIS MANUAL IS ORGANIZED

The Erosion Control Manual is organized as follows:

- **Chapter 1** states the purpose and applicability of the Erosion Control Manual, defines why erosion and sediment are a problem, and outlines how the manual is organized.
- **Chapter 2** identifies requirements that apply to all development and ground-disturbing activities whether or not a permit is required. It includes minimum requirements for all sites, additional requirements for special sites, and required maintenance procedures.
- **Chapter 3** defines when an Erosion, Sediment, and Pollutant Control Plan (ESPCP) must be prepared and defines ESPCP requirements. It also outlines the ESPCP review and approval process; summarizes recommended best management practices (BMPs) for various types of sites and construction; provides a checklist for developing an ESPCP; and provides guidance for preparing an erosion control sequencing plan.
- **Chapter 4** describes various types of erosion prevention and sediment control BMPs. Information provided for each BMP includes the purpose; conditions where the practice

applies and where it shall not be used; design criteria and specifications; maintenance specifications; removal specifications; installation tips; signs of failure; and detail drawings.

- **Chapter 5** provides guidance for controlling other liquid and solid waste materials (besides sediments) that can be generated during development activities. It describes some of the most common site pollutants generated by development activity; identifies hazardous and special wastes that may require additional controls and/or consideration; and describes development activity control BMPs.

2 GENERAL REQUIREMENTS

2.1 INTRODUCTION

The following requirements from Title 10 apply to all development and ground-disturbing activities whether or not a permit is required (unless otherwise noted ¹), unless such activities are otherwise exempted by Portland City Code. Erosion control BMPs are required during all ground-disturbing activity until permanent site groundcovers are in place.

Although Title 10 does not directly address the delivery of dirt and other landscaping materials, many of the BMPs in this manual may be used to control materials onsite. Placement and storage of delivered materials are required to comply with Title 10 and other sections of City code that prohibit discharge or deposition on streets or into sewers.

Exemptions:

Development or contract work where there is a hazard that poses imminent danger to life or property (such as substantial fire hazards, risk of flood, or other emergency) may commence without complying with the requirements during the period of the emergency. However, upon a determination by the Director² that such hazard has passed, the provisions of this title shall apply.

2.2 MINIMUM REQUIREMENTS (Portland City Code [PCC] 10.30.020)

A. Purpose

1. No visible and measurable sediment or pollutant shall exit the site, enter the public right of way or be deposited into any water body or storm drainage system.
2. Depositing or washing soil into a water body or the storm drainage system is prohibited.
3. Ground-disturbing activities requiring a permit shall provide adequate public notification of the City's Erosion Control Complaint Hotline.

B. Requirements and Standards

In order to meet the purposes stated in A above, the responsible party shall:

¹ A few of these requirements apply only to activities that require a permit and are indicated as such in the text.

² "Director" refers to the director of the Bureau of Development Services or the director of the bureau that is performing or contracting for the development or construction. (See Title 10, Section 10.10.030.)

1. Install measures intended to keep soil on site or out of water bodies, storm drainage systems or the public right of way as the first step in any development. These measures shall be made functional prior to any upslope development taking place.
2. Remove any soil that enters the public right of way.
3. Protect stormwater inlets that are functioning during the course of the development by approved sediment control measures so that sediment-laden water cannot enter the inlets without first being filtered.
4. Apply permanent or temporary soil stabilization to denuded development site areas in conformance with the following schedule:
 - Between October 1 and April 30, all denuded sites shall be provided with either temporary or permanent soil stabilization as soon as practicable, but in no case more than 2 days after ground-disturbing activity occurs.
 - Between May 1 and September 30, temporary erosion and sediment control measures to reduce dust and sediment transport shall be applied as soon as practicable, but in no case more than seven days after ground-disturbing activity occurs.
 - Groundcover shall be installed on any portion of a site that is denuded for more than six months. Sports fields or playgrounds surrounded by vegetative cover or permanently installed curbing are exempt from this requirement.
 - Temporary measures shall be maintained until permanent measures are established.
 - Ground-disturbing activity taking place between October 1 and April 30 at sites located in the Balch Creek and Forest Park subdistricts of the Northwest Hills plan district is prohibited, and is not subject to administrative review per Section 10.40.040. (See Chapter 33.563 of the City of Portland Zoning Code.)
5. Plant replacement vegetative cover that does not include plants listed in either the Nuisance or the Prohibited Plant List, as set forth in the City of Portland Plant List. Permanent non-permitted ground-disturbing activities (such as agriculture) are exempted from this requirement.
6. Secure or protect soil stockpiles throughout the project with temporary or permanent soil stabilization measures. The responsible party is accountable for the protection of all stockpiles on the site, and those transported from the site. Depositions of soil may be subject to additional regulations requiring permit, review or erosion and sediment control.
7. Select BMPs from the Erosion Control Manual. (See Chapters 4 and 5 of this manual.)

8. Post signage on the site of the permitted ground-disturbing activity that identifies the City's Erosion Control Complaint Hotline number or the responsible City project manager or inspector. Permanent non-permitted ground-disturbing activities (such as agriculture) are exempted from this requirement.
 - Post a sign on the site that is clearly visible from the right-of-way. The sign shall be at least 18" by 18" and made of materials that shall withstand weather for the duration of the project. Lettering shall be at least 3" high and easily readable. Signs shall be color coded or otherwise marked to identify the appropriate enforcing bureau.
 - Another visual notification method may be used if approved by the Director of the designated enforcing bureau.
 - Demonstrate that any trench dewatering and trench spoils will be managed onsite or provide discharge approval from the Bureau of Environmental Services for offsite discharge.
 - Identify sites where potential pollutants will be stored, used, or disposed. Such sites must provide adequate containment to prevent the release of non-soil pollutants.

2.3 ADDITIONAL REQUIREMENTS FOR SPECIAL SITES

(PCC 10.30.030)

When the Director determines that special site conditions may prevent compliance with PCC 10.30.020, the Director may require additional erosion, sediment and pollutant control measures.

A. Special site conditions may include, but are not limited to, the following:

1. Slopes before development that are greater than 10 percent (1 Vertical: 10 Horizontal).
2. Ground disturbance of a natural vegetative buffer within 50 feet of a wetland and or water body.
3. The development site is located entirely or partially within an Environmental Overlay Zone or Greenway Overlay Zone.
4. The development site or development phase will have ground disturbance at any one time of 10,000 square feet or more. Single family dwellings and duplex dwellings are exempt from this size limitation.
5. The development includes a land division containing 10,000 square feet or more.
6. Project timing is such that ground-disturbing activity will take place between October 1 and April 30.
7. The development involves discharge or offsite disposal of dewatering or trench spoils.

B. Additional requirements imposed by the Director to achieve compliance with PCC 10.30.020 A may include, but are not limited to, the following:

1. Requiring drainage control in compliance with Titles 17 and 24, during all development phases.
2. Requiring that a State of Oregon registered professional engineer, other professional certified by the State of Oregon with experience or qualifications in preparing erosion control plans, or a registered CPESC prepare and/or implement the erosion and sediment control plan.
3. Prohibiting ground-disturbing activities between October 1 and April 30.
4. Limiting the amount of denuded soil at any given time.
5. Requiring a bond, letter of credit or other guarantee.

2.4 MAINTENANCE

(PCC 10.30.040)

The following maintenance procedures are required for all permitted ground-disturbing activities to ensure that erosion and sediment control measures remain effective.

1. The responsible party shall maintain all erosion, sediment and pollutant control measures, temporary and permanent, in proper functioning order.
2. The responsible party shall maintain, adjust, repair, and replace erosion, sediment and pollutant control measures within 24 hours following a storm event to ensure that the measures are functioning properly.
3. During active ground disturbing activity, the responsible party shall inspect and maintain erosion, sediment and pollutant control measures daily between October 1 and April 30.
4. All inspections by a responsible party shall be noted in an inspection log indicating the date and time of the inspection. The inspection log shall be made available to the Director upon request.
5. All site public notification signs required by 10.30.020 shall be maintained to remain easily readable from the public right-of-way throughout the duration of the ground disturbing activity. (For permit projects only.)

In addition to the requirements identified above, Title 10 requires submittal of an Erosion, Sediment, and Pollutant Control Plan (ESPCP) for permitted development projects if the disturbance area is 500 square feet or greater in area or if the disturbance is in a special site. Chapter 3 of this manual addresses ESPCP requirements.

3 EROSION, SEDIMENT, AND POLLUTANT CONTROL PLANS (ESPCPS)

3.1 INTRODUCTION

An Erosion, Sediment, and Pollutant Control Plan (ESPCP) is required for ground-disturbing activity that exceeds 500 square feet and that requires a City of Portland building, public works, or development permit (PCC 10.40). In addition, an ESPCP may be required for sites on steep slopes, in environmental zones, in greenway overlay zones, or in response to a violation of the City's erosion control requirements.

3.1.1 Definition and Purpose

An ESPCP is a detailed description of where and how activities will be implemented to control erosion, sediment, and pollutants on a development site. The ESPCP is a central, specific component of the overall site development management plan. The ultimate goal of erosion prevention is to limit the time and area of ground disturbance, keep pollutants separate from stormwater runoff, and establish permanent groundcover as quickly and thoroughly as possible.

3.1.2 Preparation

ESPCPs shall be developed by a professional knowledgeable in erosion and sediment control. The responsible party shall designate an individual to be responsible for onsite installation, maintenance, and removal of ESPCP measures. The ESPCP shall be submitted and approved prior to any ground disturbance

A Certified Professional in Sediment and Erosion Control (CPESC) or a licensed Professional Engineer with the State of Oregon may be required to prepare the ESPCP for special sites or when a major plan revision is required because of site violations.

Sites that require an Oregon Department of Environmental Quality (DEQ) 1200-C construction site permit are encouraged to submit the same ESPCP for both the 1200-C permit and the City development, building, or street opening permit. The City of Portland does not administer the state 1200-C permit program, but does have limited signoff authority for discharged runoff.

3.2 ESPCP REQUIREMENTS

The ESPCP shall meet the following requirements:

- Demonstrate compliance with the minimum requirements of PCC 10.30.020. (See Section 2.2 of this manual.)
- Show compliance with all special requirements mandated by the Director.
- Identify any wetland, water body or outfalls within 200 feet of the ground-disturbing activity.

- Provide a simplified narrative description of existing land uses and proposed land use. Provide a copy of any applicable land use review documents.
 - Provide clear delineation and approximate size of the area to be disturbed. Show existing and proposed ground contours. Provide drainage patterns for existing and final ground contours. In addition, provide drainage patterns for all intermediate contours throughout the length of the ground-disturbing activity.
 - Show drainage controls that will be used prior to installation of a final stormwater conveyance system.
 - Indicate the name and address of all responsible parties, including the developer and property owner.
 - Identify an emergency contact and telephone number.
 - Provide a preliminary activity schedule (general construction schedule), including anticipated start and completion dates for all sequencing of ground-disturbing activity and the associated dates for installation of erosion, sediment, and pollution control BMPs. The activity schedule shall also indicate the timeframe for installation, maintenance, and removal of temporary BMPs. The applicant is responsible for notifying the City when site work will deviate from the preliminary schedule. The preliminary schedule can be modified through the designated site inspector as work on the site progresses.
 - Identify the application and maintenance of BMPs, including planning-level BMPs such as speed limits on interior roads. Show the location of all erosion, sediment, and pollution control BMPs and their position in relation to ground-disturbing activities. Identify which BMPs, if any, are permanent controls.
- See Section 3.4 below and Chapters 4 and 5 for a description of best management practices.
- Identify development activities/areas with the potential to generate pollutants, such as vehicle maintenance, fueling, trash and debris collection, dewatering discharge, and top soil or other material stockpiles. Note whether any of these activities will occur offsite.
 - Provide a simplified site landscape plan that indicates the types and amounts of vegetation to be used and when and where the vegetation will be planted. Distinguish between temporary vegetative cover and permanent site landscaping.
 - Indicate on the site plan all areas of non-disturbance and/or retention of existing vegetation.
 - For all structural erosion, sediment, and pollution control BMPs, provide a detail of installation methods, including any sizing calculations (flow volumes, rates, etc.) or reference to BMPs outlined in this manual.
 - When required by the Director, provide drainage calculations.

3.3 ESPCP REVIEW AND APPROVAL

- The Director may require a pre-construction conference with the responsible party to review the erosion, sediment, and pollution control requirements and procedures.
- The Director may deny a plan if it is determined that the plan either does not meet the requirements of Title 10 and the Erosion Control Manual or does not meet the intent of Title 10. Review of ESPCPs will look for the following approval criteria:
 - Efforts to minimize area of disturbance.
 - Use of combination of BMP types, not just sediment controls. Good plans will include at least one type of BMP from each BMP group in the manual (site entry, perimeter, stormwater, erosion prevention, etc.).
 - Use of stabilized construction entrances away from the low points of sites. Use of multiple entrances for large sites.
 - A specific construction schedule.
 - Description of stormwater controls prior to storm sewer or infiltration system installation.
 - Description of vehicle storage, maintenance, and fueling practices. Designation of staging areas, if appropriate.
 - Description of designated and protected materials storage and stockpile areas.
 - Description of site inspection and maintenance requirements for all BMPs after any storm event.
- Approval of the ESPCP is based on meeting the minimum requirements outlined in the Erosion Control Manual, in accordance with the anticipated site conditions and schedule. During the construction period, measures in the ESPCP shall be upgraded as needed for unexpected storm events and to ensure that sediment and sediment-laden water do not leave the site. Approval of a plan may be granted with or without restrictions. Restrictions on a plan may include, but shall not be limited to, the following:
 - Work is conducted only during a specified time of the year.
 - Only a portion of the work is approved.
 - Oversight by an erosion control professional is mandated.

Approval of an Erosion, Sediment, and Pollutant Control Plan by the City of Portland does not relieve the applicant's responsibility to ensure that the approved erosion control BMPs are constructed and maintained to contain sediment and pollutants on the construction site.

3.4 RECOMMENDED BMPs

Table 3-1 shows BMPs that are recommended for various types of sites and construction. These BMPs are described in detail in Chapters 4 and 5 of this manual.

Table 3-1 Recommended BMPs

BMP	Slopes <2%	Slopes 2-20%	Slopes >20%	Stockpiles	Rights-of- Way	Commercial / Industrial/ Subdivision	In-Water Work
Site Entry BMPs							
Rock Construction Entrances	X	X	X			X	
Wheel Wash Structures			X			X	
Curb Ramps	X	X	X			X	
Perimeter Sediment Control BMPs							
Sidewalk Subgrade Barriers	X	X				X	
Temporary Sediment Control (Silt) Fences	X	X	X	X		X	
Filtration Bags and Socks	X	X	X	X		X	
Fiber Rolls and Wattles	X	X	X	X	X	X	X
Vegetated Buffers	X	X				X	X
Storm Drain Inlet Protection	X	X	X		X	X	
Filtration Berms	X	X				X	
Stormwater Control BMPs							
Interceptor Dikes and Swales		X	X			X	X
Check Dams		X	X			X	
Pipe Slope Drain		X	X			X	
Stormwater Barriers (e.g., hay bales, triangular silt dikes, plastic dams, rock sack berms)		X	X	X		X	X
Sediment Traps and Ponds	X	X				X	
Other Measures: (not included in this manual; alternative method review required through Bureau of Development Services (BDS)) <ul style="list-style-type: none"> Flocculants Coagulants Temporary Downspout Controls Rolling Dips Water Bars 	X	X	X		X	X	X

BMP	Slopes <2%	Slopes 2-20%	Slopes >20%	Stockpiles	Rights-of- Way	Commercial / Industrial/ Subdivision	In-Water Work
Erosion Prevention BMPs							
Surface Roughening	X	X	X			X	
Temporary Grasses and Permanent Vegetative Cover	X	X	X	X		X	
Mulch	X	X	X	X		X	
Erosion Control Blankets		X	X	X		X	
Plastic Sheet Covering				X		X	
Dust Control					X	X	
Armoring			X				
Live Stakes			X				X
Live Fascines			X				X
Instream BMPs							
Instream Sediment Trapping Devices							X
Development Activity Control BMPs							
Dewatering	X	X	X		X	X	X
Spill Prevention and Control	X	X	X		X	X	
Solid Waste and Materials Management	X	X	X		X	X	
Vehicle and Equipment Fueling	X	X	X		X	X	
Vehicle and Equipment Maintenance	X	X	X		X	X	
Concrete Waste Management	X	X	X		X	X	
Structure Preparation and Painting	X	X	X		X	X	

3.5 CHECKLIST FOR DEVELOPING AN ESPCP

The following checklist is provided to help the user create an ESPCP that minimizes erosion through site planning, activity sequencing, and development layout. Not all elements apply to all sites; because development projects vary widely, ESPCPs will vary, too. Some large sites may need to address issues that do not occur on smaller sites.

Section 3.6 provides additional guidance specific to erosion control sequencing.

3.5.1 Define the Project

- Have you defined project phases? Projects have at least three phases: clearing, infrastructure installation, and final unit construction. Large sites may be developed in a phased/sectional manner, with some phases/areas completed before adjacent areas begin development. The clearing phase should include defining non-disturbance areas and establishing perimeter controls.
- What is your construction schedule? If it is between October 1 and April 30, you will need wet-weather BMPs. Identify where additional erosion control materials will be stored onsite for use during rain events.
- Is specific training or onsite meetings required for contractors? Identify the topics that must be discussed—e.g., BMP maintenance, site access, materials storage, recycling and waste control, work windows for wet weather or instream work.
- Do you need a professional to help develop an ESPCP? For example, any type of pond or other water impoundment requires a licensed professional engineer.
- Will you be carrying out any pollution-generating activities (concrete washout, vehicle fueling or maintenance, dewatering, painting)? If so, you must designate areas for these activities, construct any necessary structures or facilities for them, and identify necessary procedures for controlling discharges.
- Will you be storing materials onsite, such as soils, bulk construction material, or potential pollutants? If so, your plan must show the locations and identify control measures for them.

3.5.2 Characterize the Site

- Is your site larger than one acre? If so, you must apply to DEQ for a 1200-C construction stormwater permit.
- Is your site on streambanks or in a waterway? If so, you must receive approval from appropriate local, state, and federal agencies before starting work. There may also be restrictions on when you can carry out in-water work.

- Define the site topography. Look for ways to clear the area along the elevation contours, which can reduce erosion. If there are steep slopes, consider which BMPs will be effective in controlling stormwater runoff, protecting slopes from erosion, and avoiding cutting of channels and rills.
- Identify any wetlands, water bodies, or other protected areas (such as environmental zones) on your site. Show them clearly on your plans, and prepare to protect them as no-disturbance areas with construction fencing in the field.
- Identify the site's soil characteristics. Different soils have different erodibility and infiltration characteristics. Consider how the soils may affect the performance of your site BMPs.
- Where and how many site access points will you need? Ideally, access points should be placed away from low areas and with sufficient sight lines to any active roadway.
- Identify the need for stormwater conveyance before, during, and after construction. Are there areas where runoff crosses the property? Consider the use of stormwater BMPs to route water around the worksite. Identify offsite stormwater disposal points.
- Identify any groundwater seepage areas onsite.

3.5.3 Identify the Measures

- Is a pre-construction onsite conference required, or do you wish to hold one?
- Identify the locations for stabilized construction entrances.
- Select at least two erosion prevention BMPs for use on the site.
- Select and locate perimeter control BMPs prior to ground disturbance.
- Develop measures for temporary cover of exposed soils. Specify timeframes for applying seed or mulch after completion of project phases.
- Develop permanent cover BMPs. If using vegetation, provide irrigation and nutrients as appropriate.
- Define contingency plans in case BMPs fail. Include plans for obtaining needed materials, and identify emergency responders.
- Specify the inspection and maintenance schedule for all BMPs on the plan set. BMPs must be inspected daily in most cases. Identify the persons responsible for inspection and maintenance. Supply maintenance and inspection logs.
- Identify a responsible party for post-construction BMP maintenance, and specify a schedule.

- Mimic existing drainage patterns and vegetative cover. By retaining or enhancing existing drainage patterns, flooding problems will be minimized. Where existing site vegetation is preserved, erosion prevention is already in place and there is no cost of re-landscaping.
- Design structures on contour. When natural contours are followed, drainage and sediment migration are controlled by running infrastructure and other elements parallel, rather than perpendicular, to the slope.
- Consider using temporary control features for permanent erosion control. For example, a swale that functions to divert and slow runoff during construction can serve the same purpose after the project is completed. Similarly, using pre-existing permanent vegetation for erosion control reduces ground disturbance as well as the need to reclear and replant the site.
- If you plan to use any measures not identified in this manual, arrange for an alternative method review through the Bureau of Development Services, Site Services Section.

3.6 EROSION CONTROL SEQUENCING PLAN

Thoughtful project scheduling can support erosion control measures and avoid potential problems. The larger the site, the more important it becomes to consider erosion and sediment control as a separate element shaping the project's construction sequencing. An erosion control sequencing plan is a required part of the ESPCP and should be developed as part of the overall construction site schedule. The sequencing plan shall identify the various BMPs to be used, define when and where they are to be used, and describe any maintenance requirements.

In developing the sequencing plan, analyze the site and the anticipated construction schedule for the various aspects of the site, including the need for clearing, grubbing, grading, utility installation, structural improvements, and landscaping. Consider such factors as time of year, anticipated weather, activity duration, and how to minimize the area of soil exposed at any one time. Considering the time of year and area of soil exposure, identify activities that create a high risk for soil movement by air or by water. Important factors that may influence the sequencing plan include:

- Existing site conditions
- Site entry and staging of materials and equipment
- Drainage, road, and utility installation
- BMPs identified for onsite and perimeter erosion and sediment control
- Opportunities for material reuse and recycling
- Need for waste storage and disposal

Table 3-2 identifies suggested site sequencing. It includes a “menu” of various possible activities, including erosion and sediment control BMPs and other relevant site activities (e.g., utility tie-in controls) that must be addressed at the various construction stages. These activities are listed in the order in which they should generally be implemented.

Table 3-2 Suggested Site Sequencing

Small Site (less than or equal to 1 acre)	Large Site (greater than 1 acre)
Entry Control BMPs Rock construction entrance Curb ramp Sidewalk cut	Limit of Clearing Activities Designate vegetation protection areas
Perimeter Controls Buffers Sediment fence Inlet protection	Perimeter Controls Include stormwater collection conveyance systems if needed
Drainage Controls Diversion ditches Pipe slope drains	Entry Control BMPs Rock construction entrance and gravel roads Curb ramp Wheel wash
Sediment Control Features Barriers Inlet protection	Clearing and Grubbing BMPs Limit to area needed for public works and utilities
Foundation Erosion and Sediment Control BMPs Control of side casting Dewatering Cover	Stripping and Soil Stockpiling BMPs Siting Perimeter control Cover
Stockpiling BMPs Siting Perimeter control Cover	Rough Grading Controls Limit to area needed for public works and utilities
Backfill Erosion and Sediment Control BMPs Control of materials movement	Utility Installation Controls Control of side casting and materials movement
Utility Tie-In Controls Control of side casting Specific stockpiles	Backfill/Bedding Erosion and Sediment Control BMPs Temporary vegetation and/or cover
Final Grading Erosion and Sediment Control BMPs During process	Foundation Erosion and Sediment Control BMPs Control of side casting Dewatering
Vegetation Cover Control materials Irrigation flows	Backfill Erosion and Sediment Control BMPs Control of materials movement
Temporary Erosion and Sediment Control BMPs Removal schedule	Final Grading Erosion and Sediment Control BMPs During process
	Vegetation Cover Control materials and irrigation flows
	Temporary Erosion and Sediment Control BMPs Removal schedule

Note: Assumes routine inspection, maintenance, and replacement of BMPs as needed.

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4 EROSION PREVENTION & SEDIMENT CONTROL BMPs

4.1 INTRODUCTION

Best management practices (BMPs) can be grouped into two broad categories:

- **Erosion prevention** is the use of practices designed to protect the surface of the soil from the force of rain, wind, and other runoff so soil particles will not dislodge (erode) and be transported off the construction site as sediment. These practices include establishing a vegetative cover, controlling stormwater runoff, and/or providing protective covers for exposed soils.
- **Sediment control** is the use of practices designed to capture soil particles after they have been dislodged and become sediment and the attempt to retain the sediment onsite. These practices include installing sediment fencing, sediment traps, or ponds.

Both erosion prevention and sediment control have appropriate uses, but erosion prevention BMPs are more effective in preventing soil particles from leaving the construction site. Once soils are dislodged, they are very difficult to recover.

4.2 SITE ENTRY BMPS

Control of access to and from a site of ground disturbance can go a long way toward controlling migration of sediments off the worksite. Site entry BMPs should be the first erosion measures installed at any site.

4.2.1 Rock Construction Entrances

Purpose

To construct a stabilized pad of rock at entrances/exits to construction sites in order to contain sediments onsite and minimize the amount of mud, dirt, rocks, etc. transported onto roads by motor vehicles or stormwater runoff.

Conditions Where Practice Applies

- At any construction site where traffic will be leaving the site and moving directly onto public roads, paved areas, or other approved access points.

Shall Not Be Used

- When paved onsite access is available.
- Across streams and other drainage channels.

Design Criteria/Specifications

- See Figure 4.2-A for detail drawing.
- A rock construction entrance shall be the first site BMP installed after fencing off areas of no disturbance and establishing perimeter controls. No removal of stripped material is allowed until after the rock entrance is established.
- Material shall be “clean” (less than 5 percent passing the US Standard No. 200 sieve).
- Material shall be at least 1½ inch on all sites. Larger rock (2 to 6 inches) is necessary for industrial, commercial, and subdivision sites or in conjunction with wheel wash facilities.
- Recycled aggregate consisting of crushed Portland cement concrete and crushed or ground asphaltic concrete may be acceptable if the material meets the required gradation. The recycled material shall be durable and free of deleterious material, including but not limited to vegetative matter, wood, lightweight pieces, insulation, gypsum, brick, glass, and metal, and shall meet the durability requirements described for coarse aggregates in Section 205.2.12 of the City of Portland Standard Construction Specifications.

- The rock pad shall be at least 8 inches thick and 50 feet long. Width shall be the full width of the vehicle ingress and egress area. (A 20-foot minimum pad length may be acceptable as approved for one- and two-family construction sites.)
- Subgrade reinforcement geotextile shall be used under gravel pads for all construction except one- or two-family residences on existing lots of record.
- Articulated blocks, mats, and steel plates may also be used for construction entrances.
- Sediment control BMPs such as wattles and sediment fence shall be used to protect construction entrances from siltation from adjoining bare soil areas.

Additional BMPs

- Gravel filter berms shall be constructed across onsite traffic wheel paths to capture and retain sediment. Berms shall be 1 foot high with 1V:3H side slopes, constructed of ¾-inch to 3-inch crushed rock with less than 5 percent fines. Berms shall be inspected regularly, and accumulated sediment shall be removed, with rock added or replaced as needed. Berms shall be spaced as follows:
 - Every 300 feet on slopes less than 5 percent
 - Every 200 feet on slopes between 5 and 10 percent
 - Every 100 feet on slopes greater than 10 percent
- If sediment is tracked offsite, additional BMPs shall be implemented. These BMPs may include washing wheels before vehicles leave the site or other construction techniques or work operation modifications. Wheel washing shall be done on the rock pad or in an approved wheel wash structure located onsite. The wheels shall be washed before crossing the rock pad to leave the site. (See wheel wash BMP on page 25).

Maintenance Specifications

- The construction entrance shall be inspected daily. The entrance shall be maintained in a condition that will prevent tracking or flow of sediment onto public rights-of-way or other hard impervious surfaces. This may require periodic top-dressing with additional material or washing and reworking the existing material as conditions demand. Maintenance shall include the repair and/or cleanout of any structures used to trap sediment.
- All materials spilled, dropped, washed, or tracked from vehicles onto roadways or into the stormwater collection system shall be removed or cleaned up immediately, and no later than end of the work day. The use of water trucks to wash the material off the roadway is not allowed. Water trucks may be used immediately before sweepers or vacuum systems to loosen sediment, provided that discharge to the stormwater collection system does not occur.

Removal Specifications

The need for the construction entrance diminishes when vehicles are no longer entering and exiting the site. The construction entrance may be removed if construction activities have ceased, a permanent pad or surface has been established, light and heavy construction traffic has ceased or no longer needs to enter the site, or another entrance has been established. A construction entrance shall not be removed without the proper approval and authorization of an inspector. Once an entrance has been approved for removal, temporary or permanent groundcover shall be promptly established.

Note: Construction entrance materials can be easily recycled, washed, or reused, and recycling or reuse is encouraged.

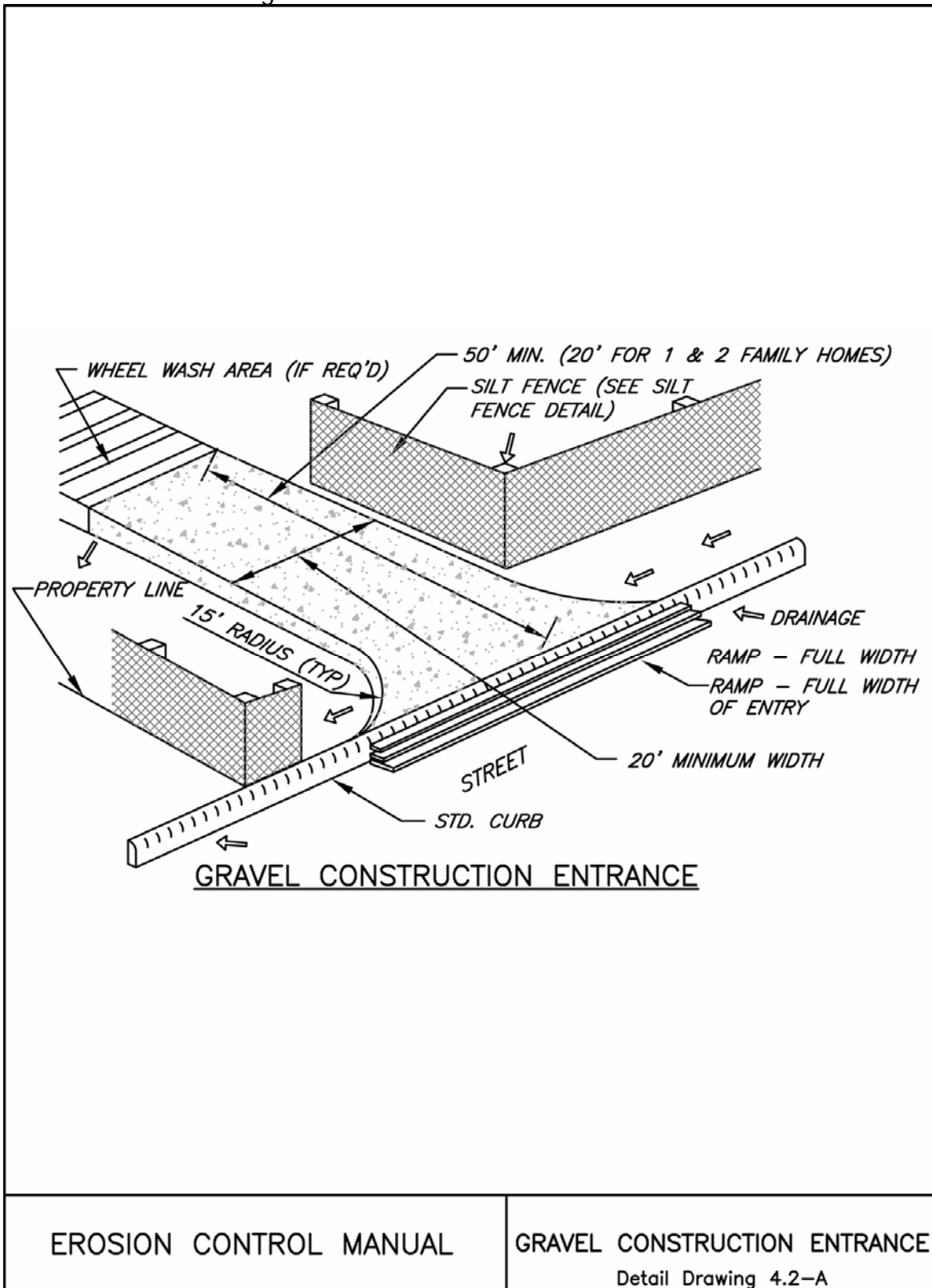
Installation Tips

- Install the construction entrance as the first site BMP after any exclusion zones have been identified and fenced or otherwise protected.
- Install in locations where permanent roadways and driveways will be located.
- Install multiple layers of geotextile fabric and rock so that rock can be easily collected for reuse as subbase material under a driveway.
- If possible, locate entry on upslope side of lot to avoid concentrating and diverting runoff into the street.
- Consider use of multiple entries to access large or difficult sites.
- Add a wheel wash area as required.

Signs of Failure

Symptoms	Causes	Solutions
Tracking mud into the street.	<ul style="list-style-type: none">• Rock contaminated or insufficient.• Lack of proper maintenance.	<ul style="list-style-type: none">• Add larger rock, increase depth of rock, or stabilize a larger area.• Add a wheel wash facility.• Physically remove surface mud from tires.
Dust generation.	<ul style="list-style-type: none">• Lack of moisture on site roads.• Friable soils onsite.	<ul style="list-style-type: none">• Add additional rock or lengthen drive.• Use a water truck to keep dust down (control amount and type of spray to minimize erosion).• Use a wetting agent on roadways. (See Dust Control BMP on page 112.)

Figure 4.2-A Rock Construction Entrance



4.2.2 Wheel Wash Structures

Purpose

Wheel wash structures are intended to remove mud and sediment from tires and undercarriages of vehicles moving off the site. The sediment is trapped in the wheel wash structure, and wash water is reclaimed, infiltrated, or discharged in an approved manner.

Conditions Where Practice Applies

- Wheel wash facilities are required when other measures prove inadequate to prevent mud or sediment from being tracked off the construction site.

Note: When a wheel wash facility is required because of sediment tracking, no further traffic is allowed until the facility is constructed and shown to function.

Design Criteria/Specifications

- See Figures 4.2-B and C for detail drawing.
- Mobile wheel wash units and bump ramp-type products are allowed, but must be installed in accordance with the manufacturer's recommendations.
- The structure shall be established on a grade not greater than 1 percent.
- The wash shall have a minimum 50-foot-long run-out area for vehicles leaving the wash. The run-out area shall consist of construction-entrance rock.
- The wash shall be at least 18 inches deep, with a constant minimum water-pool depth of at least 12 inches.
- Wheel washes shall be constructed as shown in Figures 4.2-B and C (a layer of filter fabric covered by 12 inches of compacted, crushed rock or as designed by a licensed engineer.
- Wash water shall be drained through a sediment-trapping structure before leaving the construction site. All offsite discharges require approval from BES Source Control (503-823-7122). For information about treatment and disposal of wastewater, contact BES Source Control.

Maintenance Specifications

The facility shall be inspected daily. Trapped sediment shall be removed to ensure that vehicles do not pick up sediment in the wash facility itself.

Removal Specifications

The wheel wash may be removed when construction activities have ceased, a permanent pad or surface has been established, or light and heavy construction traffic has ceased or no longer needs to enter the site. Any soils exposed by removing the wheel wash facility shall be promptly covered by temporary or permanent groundcover.

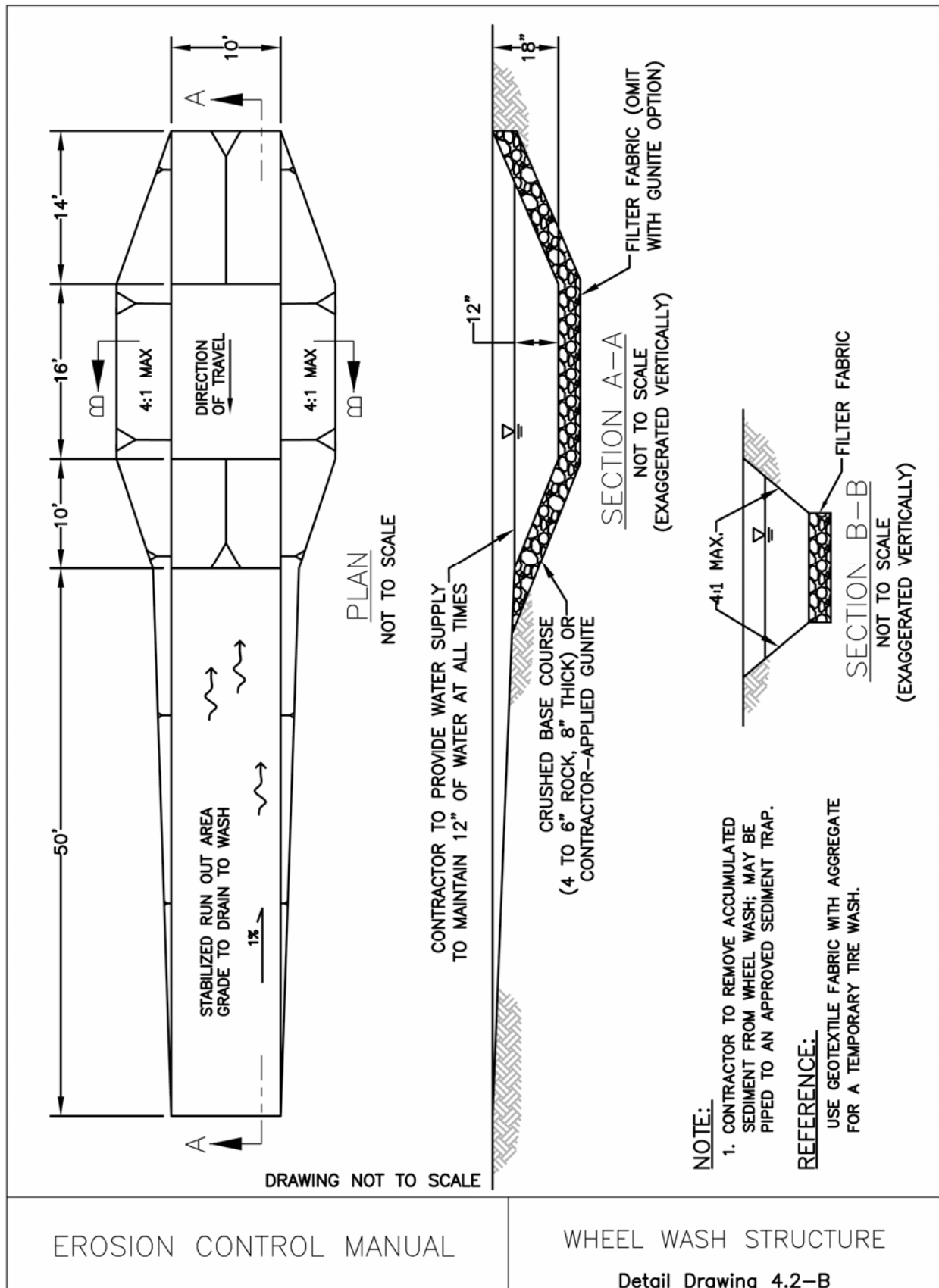
Installation Tips

- Provide separate site entry and exits on large sites, and use large rock (4- to 6-inch gabion rock) at the approach and the drive-out space for the wheel wash.
- Install the facility near a water source and a sanitary connection.
- Consider a recycled pumped system or mobile units.

Signs of Failure

Symptoms	Causes	Solutions
Mud stays on tires.	<ul style="list-style-type: none"> • Sediment exceeds one-third of wash facility capacity. • Reuse of turbid water. • Insufficient water spray intensity and/or volume available. • Insufficient water contact time. 	<ul style="list-style-type: none"> • Remove sediment buildup in wash facility. • Replace water used in facility. Appropriately dispose of removed materials. • Increase water pressure. • Clean water feed lines/spray heads. • Adjust site exit procedures to allow for soak time in wash facility. • Add second wheel wash. • Add a grate to vibrate sediment off of tires.

Figure 4.2-B Drive-Through Wheel Wash Structure



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4.2.3 Curb Ramps

Purpose

To provide ramp access to a stabilized construction entrance without blocking stormwater flow or adding sediment to curb runoff.

Conditions Where Practice Applies

- Any area needing access from a paved surface to a rock construction entrance.

Design Criteria/Specifications

- See Figure 4.2-D for detail drawing.
- A wooden ramp shall be built from three or more planks of increasing size wood, offset to allow for drainage. Other materials may be used, such as steel plates. Gravel or road base is not allowed for ramp construction.
- If wood is used, it shall be untreated wood of 2 x 4 to 4 x 12 dimensions and shall be attached using nails, screws, adhesive, or other approved fastening system.
- A minimum 2-inch gap for drainage shall be cut or left in the offset stack adjacent to the curb. Drainage shall be routed through this opening.
- Larger, long-term projects may use hot-mix asphalt ramps that will be removed when the permanent drive is installed. Cold asphalt is not allowed because of its lack of durability. Asphalt shall be poured for at least 2 feet of gradual slope between the curb and street level and shall have sanded connection joints. Adequate drainage conveyance controls are required.
- The ramp shall not impede any travel lanes in the right-of-way, including bike lanes.

Maintenance Specifications

- Inspect the ramp daily to ensure that nails, screws, or adhesives are in good condition.
- Remove sediment and other debris when it begins to accumulate behind or upslope from the ramp.
- Replace any ramp pieces that become cracked or damaged and can no longer provide structural support.

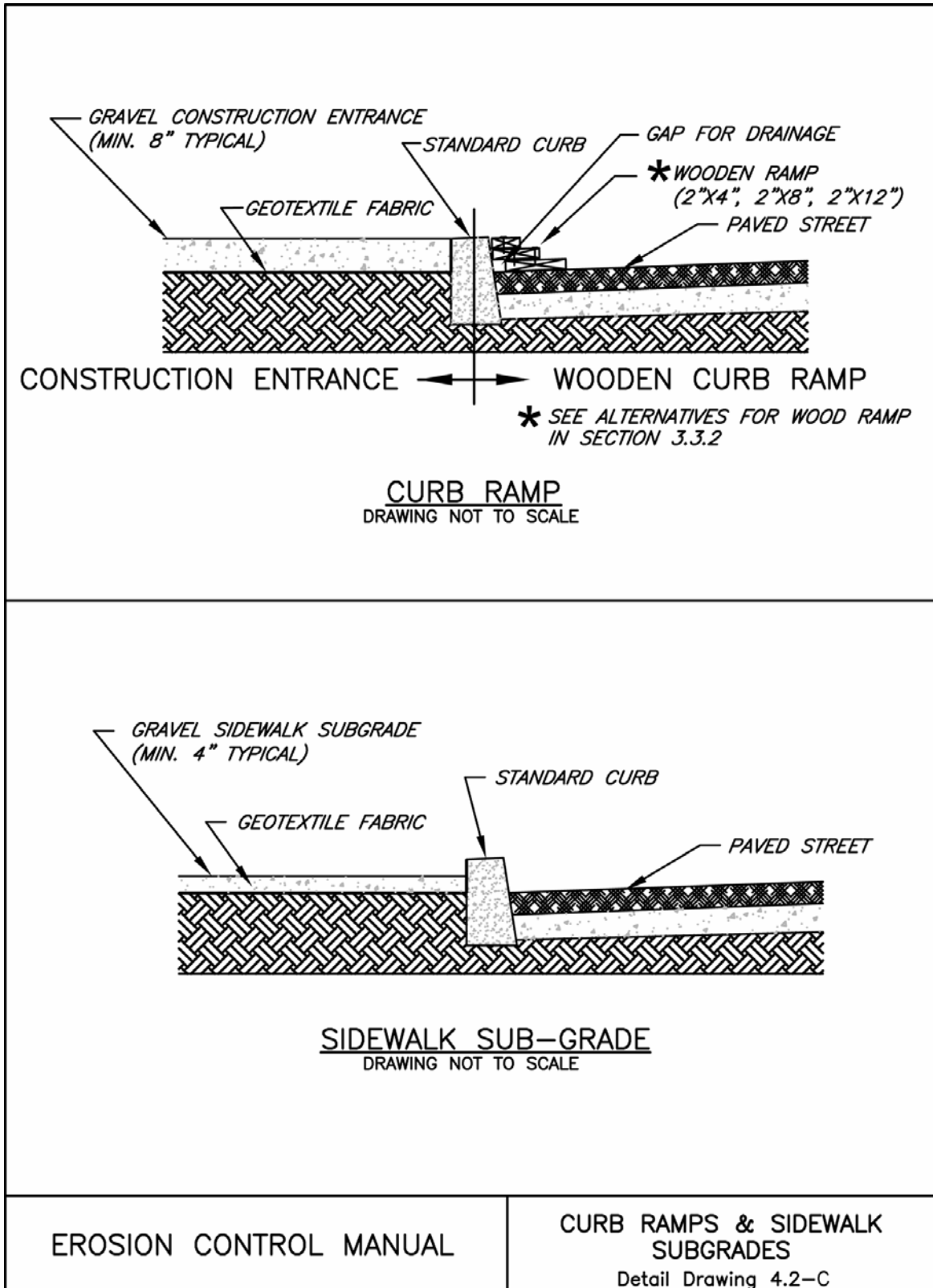
Removal Specifications

The curb ramp may be removed when a permanent pad or surface has been established or when light and heavy construction traffic has ceased or no longer needs to enter the site.

Signs of Failure

Symptoms	Causes	Solutions
Water ponding at curb.	<ul style="list-style-type: none">• Undersized or missing drainage passage space/device.• Plugged drainage space/device.	<ul style="list-style-type: none">• Upsize or provide drainage space or device flush to curb.• Clean area at least 2 feet upstream of ramp and blow out material collected in space/device.

Figure 4.2-C Curb Ramps and Sidewalk Sub-Grade Barriers



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4.3 PERIMETER SEDIMENT CONTROL BMPS

Perimeter sediment control BMPs are the last protection before sediment enters the roadway, storm drains, or adjacent properties. They must be installed before starting any site grading activities. Perimeter sediment control BMPs can be the most visible and most frequently vandalized BMPs on a site.

4.3.1 Sidewalk Subgrade Barriers

Purpose

To minimize the transport of sediment from a construction site by using the sidewalk subgrade gravel as a temporary trap for sediment-laden runoff.

Conditions Where Practice Applies

- One- and two-family residential construction sites, where the site slopes to a street with planned but unbuilt sidewalks and site slopes are less than 5 percent.

Shall Not Be Used

- By themselves on slopes >5 percent.
- In areas of high runoff volume.

Design Criteria/Specifications

- See Figure 4.2-D for detail drawing on page 31.
- Excavate a minimum of 8 inches behind existing curbing. Line with a geotextile fabric. Backfill with a minimum of 4 inches of gravel, leaving a 4-inch air gap/freeboard as capture depth behind the curb.
- Sidewalk subgrade gravel shall be in place during the entire construction period, from the time of initial site clearing/grading through establishment of permanent site cover. If the sidewalk concrete is to be poured before permanent site cover is established, approved sediment barriers shall be installed before pouring concrete.

Maintenance Specifications

- Remove sediment when it accumulates to within 2 inches of the top of the curbing. All materials spilled, dropped, washed, or tracked from vehicles onto roadways or into the stormwater collection system shall be removed or cleaned up immediately. The use of water trucks to remove this material is not permitted under any circumstances.

- Replace rock when surface voids in gravel are no longer visible. This may require periodic top dressing with additional gravel or rock, or washing and reworking the existing material, as conditions demand.
- If the sidewalk subgrade gravel does not provide an effective filter and sediment is leaving the construction site, additional BMPs shall be applied. These may include replacement of gravel or installation of additional sediment barriers.

Removal Specifications

Subgrade gravel may not meet the City's specifications for sidewalk concrete placement if too much sediment has infiltrated the rock. Routine sediment removal and onsite erosion prevention BMPs will help protect reuse of these gravels. The permittee must weigh the benefits of eliminating sediment barriers versus the possibility that the City may reject the subgrade gravel. It may be cost effective to wash and reuse materials.

Installation Tips

- Excavate to finish subgrade so fabric and gravel may remain permanently in place. Remove contaminated material adequate to pave sidewalk.
- Use with silt fence, mulch, or gravel behind the curb or at property line.
- For cross slopes >5 percent and at property corners, add winged sections to silt fence behind curb.

Signs of Failure

Symptoms	Causes	Solutions
Sediment in road.	<ul style="list-style-type: none"> • Sediment has overtopped subgrade capture area. • Lack of proper maintenance. • Concentrated stormwater flow from above the subgrade area. 	<ul style="list-style-type: none"> • Remove sediment buildup. • Mulch or prevent erosion from contributing areas. • Pipe away concentrated stormwater flows. • Use a spreader to disperse concentrated flows evenly across the site.

4.3.2 Temporary Sediment Control (Silt) Fences

Purpose

To minimize the transport of sediment from a construction site by providing a temporary physical barrier to sediment movement and reducing runoff velocities. Silt fences have limited capacity to filter sediment from flows.

Conditions Where Practice Applies

- Downslope of disturbed areas where runoff occurs as sheet runoff.
- At the toe of soil stockpiles.
- At intervals along the contours of large disturbed areas.
- At grade breaks exceeding 20 percent, up to 50 percent only.

Shall Not Be Used

- By themselves on slopes steeper than 2 horizontal to 1 vertical (2H:1V). Silt fences shall be used in conjunction with other measures on these slopes.
- Across streams and other drainage channels.
- For work on paved streets or other paved surfaces.
- Upslope of disturbance areas. Surrounding the entire site with silt fence is neither required nor recommended.
- Silt fences are most effective for trapping granular or coarse materials and shall not be relied on to reduce turbidity.

Design Criteria/Specifications

- See Figure 4.3-A for detail drawing.
- A trench shall be cut along slope contours and around stockpiles for silt fence installation. Filter fabric fence shall have a minimum vertical burial of 6 inches. All excavated material from filter fabric fence installation shall be firmly redeposited along the entire trenched area on the uphill side of and against the fence.
- Standard or heavy-duty filter fabric fence shall have manufactured stitched loops to fit 2-inch x 2-inch installation posts. Stapled fence products are not allowed. Stitched loops shall be installed on the uphill side of the sloped area, with posts spaced a maximum of 6 feet apart (see Figure 4.3-A).
- Where practical, the filter fabric shall be purchased in a continuous roll the length of the barrier to avoid use of joints. When joints are necessary, 2-inch by 2-inch posts shall be interlocked with each other and attached securely together.

- Maximum sheet or overland flow path length to silt fences shall be 100 linear feet for greater than 2:1 slopes and 50 feet for 2:1 slopes. The size of the drainage area shall be no more than 1/4 acre for each 100 lineal feet of fence. Ends of fence lines shall be angled upslope in an arcing fashion. Wings may need to be added for long lines running downslope to allow for slowing of surface flows. Silt fences also can be used in multiple rows to provide enhanced efficiency. Spacing of rows depends on the slope of the site.
- The physical integrity of all materials shall be sufficient to meet the requirements of their intended use and withstand normal wear and tear. Selection of filter fabric tensile and bursting strength depends on the slope characteristics. The use of standard or heavy-duty filter fabric that retains 85 percent of the soil by weight will meet design standards. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0 to 120 degrees F. Selection shall be based on standard engineering principles for design.
- Silt fences may also be used in combination with chain link, hay bales, fiber rolls, and biofilter bags for additional structural support and/or sedimentation effectiveness. Chain link fencing shall be placed directly down slope from the temporary silt fence for additional structural control. Hay bales may be used up slope of the silt fence for sedimentation or down slope of the silt fence for structural improvement. Biofilter bags, fiber rolls, or coarse mulch are most effective up slope of the silt fence, either adjacent to or within 3 feet up slope of the silt fence.

Maintenance Specifications

- Silt fences shall be inspected by the applicant/contractor immediately after each rainfall and at least daily during prolonged rainfall. Any required repairs, relocations, or additions shall be made immediately.
- At no time shall more than a 1-foot depth of sediment be allowed to accumulate up slope of a silt fence. Sediment shall be removed or re-graded onto slopes and the silt fences repaired and reestablished as needed.

Removal Specifications

- Fences (even those that are biodegradable) shall be removed only when upslope areas are permanently stabilized. This will require a post-construction completion visit to remove the fencing.

Installation Tips

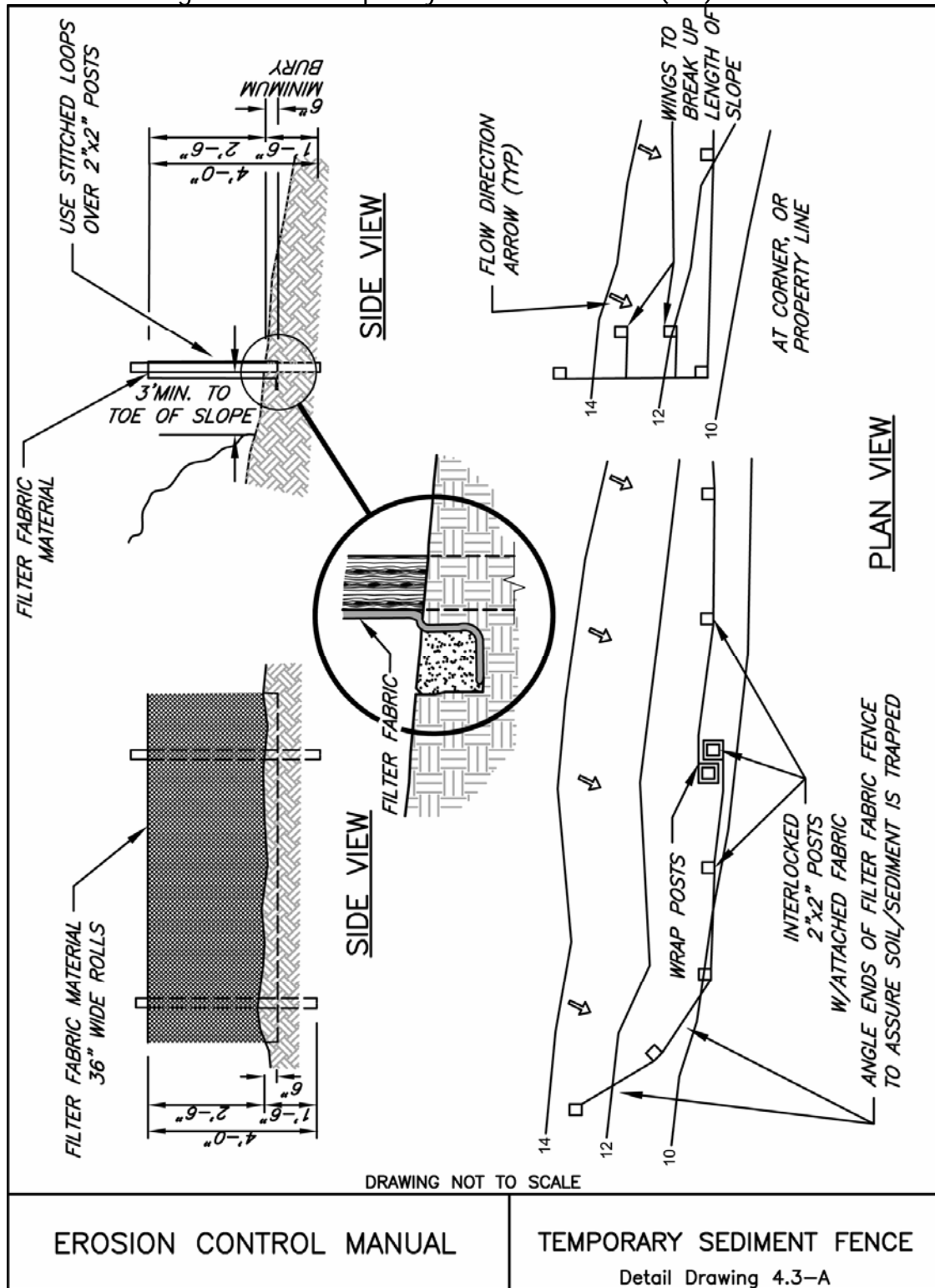
- Dig trench and embed fabric to a depth of at least 6 inches. Backfill on top of fabric. Compact soil well. Do not lay the fabric on the ground surface and pile soil onto it.
- Install silt fence on horizontal contours. Do not install fence down the slope, unless needed as a wing arm or to divert flow (see Figure 4.3-A).

- Place mulch, fiber rolls, or biofilter bags along the upslope side of the silt fence to provide additional sediment capture. This practice will keep sediment from reducing the porosity of the fence fabric.

Signs of Failure

Symptoms	Causes	Solutions
Concentrated runoff from under the fabric of the fence.	<ul style="list-style-type: none">• Bottom of fabric not properly buried.• Fence not installed on contour.• Concentrated stormwater flow from above subgrade area.	<ul style="list-style-type: none">• Reinstall on contour with bottom fabric in trench, and compact soil on top of the fabric.• Evaluate and redirect concentrated flows.
Silt fence tipping over.	<ul style="list-style-type: none">• Stakes not penetrating subgrade.• Stake pockets are downslope; fence falls as stake pocket fails.	<ul style="list-style-type: none">• Reinstall correctly, or add additional layer of sediment fencing, or install additional staking.
Excessive sediment buildup.	<ul style="list-style-type: none">• Lack of timely maintenance.	<ul style="list-style-type: none">• Clean out sediment from behind fence.

Figure 4.3-A Temporary Sediment Control (Silt) Fence



4.3.3 Filtration Bags and Socks

Definition

Filtration bags and socks are a series of contained filtration materials that can be used to slow flows and provide settling of sediments in runoff. This group includes biofilter bags, gravel socks, sand bags, compost socks, and wood fiber bags. Bags and socks are made in various sizes of plastic mesh or geotextile cloth and filled with a variety of organic or inorganic materials designed to filter and detain flows and sediment. The most common fill material is wood products, such as bark chips.

Purpose

To minimize the transport of sediment from a construction site by providing a temporary physical barrier to sediment and reducing runoff velocities.

Conditions Where Practice Applies

- At toe of soil stockpiles or slopes.
- On the upslope or downslope side of a silt fence line. (Wattles are usually better for this application.)
- As a perimeter control BMP.
- For flow control by splitting up the length of slopes.
- As check dams
- As an alternative to sediment fence wings along a downslope sediment fence.

Shall Not Be Used

- In high-flow areas.
- For catch basin protection without inlet inserts.

Plastic mesh bags are not allowed for use in public rights-of-way or traffic areas. Only solid surface geotextile bags may be used in traffic areas.

Design Criteria/Specifications

- See Figures 4.3-B, 4.3-C, and 4.3-D for detail drawings.
- Fill material shall be clean, 100 percent recycled wood, sand, gravel, or compost product. Bag size can vary, but bags are generally 18 to 20 inches long and weigh approximately 45 pounds. Bags are usually made of geotextile fabrics or open ½-inch plastic mesh.

- In traffic areas, bags shall be made of geotextile material.
- Bags used on pervious surfaces shall be staked into place. Stakes shall be installed as shown in the notes on Figure 4.3-C.

Maintenance Specifications

- Bags and socks shall be inspected daily.
- Filter bags and socks used for storm drain protection shall be replaced at least every 3 months and more often if necessary to maintain their effectiveness.
- Sediment depth shall not accumulate to more than one-third the height of the bag or sock.
- Sediment shall be removed or re-graded onto the slope, or new lines of bags or upslope of barriers that are impaired by sediment accumulation..

Removal Specifications

- Once the upslope area is stabilized, bags and socks shall be removed.
- Fill material may be incorporated as mulch after completion of site work if approved by the City. Removal will necessitate a post-construction site visit. The bags or socks shall be disposed of at a local recycling or solid waste disposal facility.

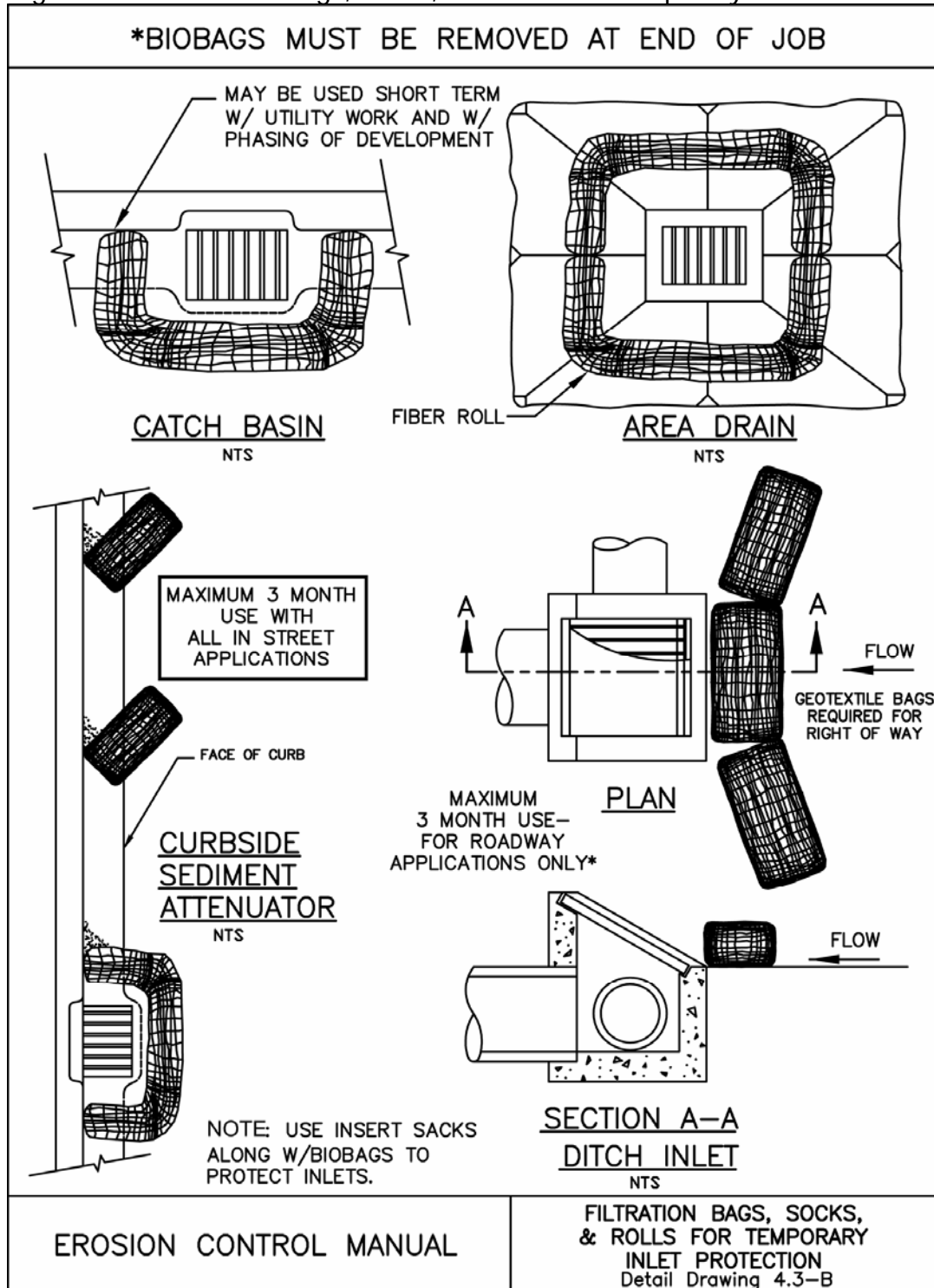
Installation Tips

- Use bags and up slope or down slope of silt fence to provide added support to the toe of the fence.
- Maintenance is critical. Remove sediment buildup, and replace or add additional bags or socks when one-third of capacity is full.
- Check remaining capacity often, since high flows, vehicle damage, and vandalism can limit performance and damage bags.
- Bags and socks are best used in low-exposure/low-sediment load areas.
- Ensure that no gaps exist under or between bags that could bypass flows. Overlap bags and socks whenever possible.

Signs of Failure

Symptoms	Causes	Solutions
Concentrated runoff or sediment flows are coming around or under bags.	<ul style="list-style-type: none">• Insufficient materials.• Insufficient stakedown during installation.	<ul style="list-style-type: none">• Add additional materials and align to contain flows.• Reinstall with proper staking and entrenchment.
Sediment is overwhelming bags.	<ul style="list-style-type: none">• Lack of upslope BMPs.• Inadequate maintenance.	<ul style="list-style-type: none">• Add erosion prevention or other sediment control BMPs.• Clean sediment from behind bags or rolls.

Figure 4.3-B Filtration Bags, Socks, and Rolls for Temporary Inlet Protection



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Note: Use insert sacks along with biobags to protect inlets.

Figure 4.3-C Slope Installations: Filtration Bags, Socks, and Rolls

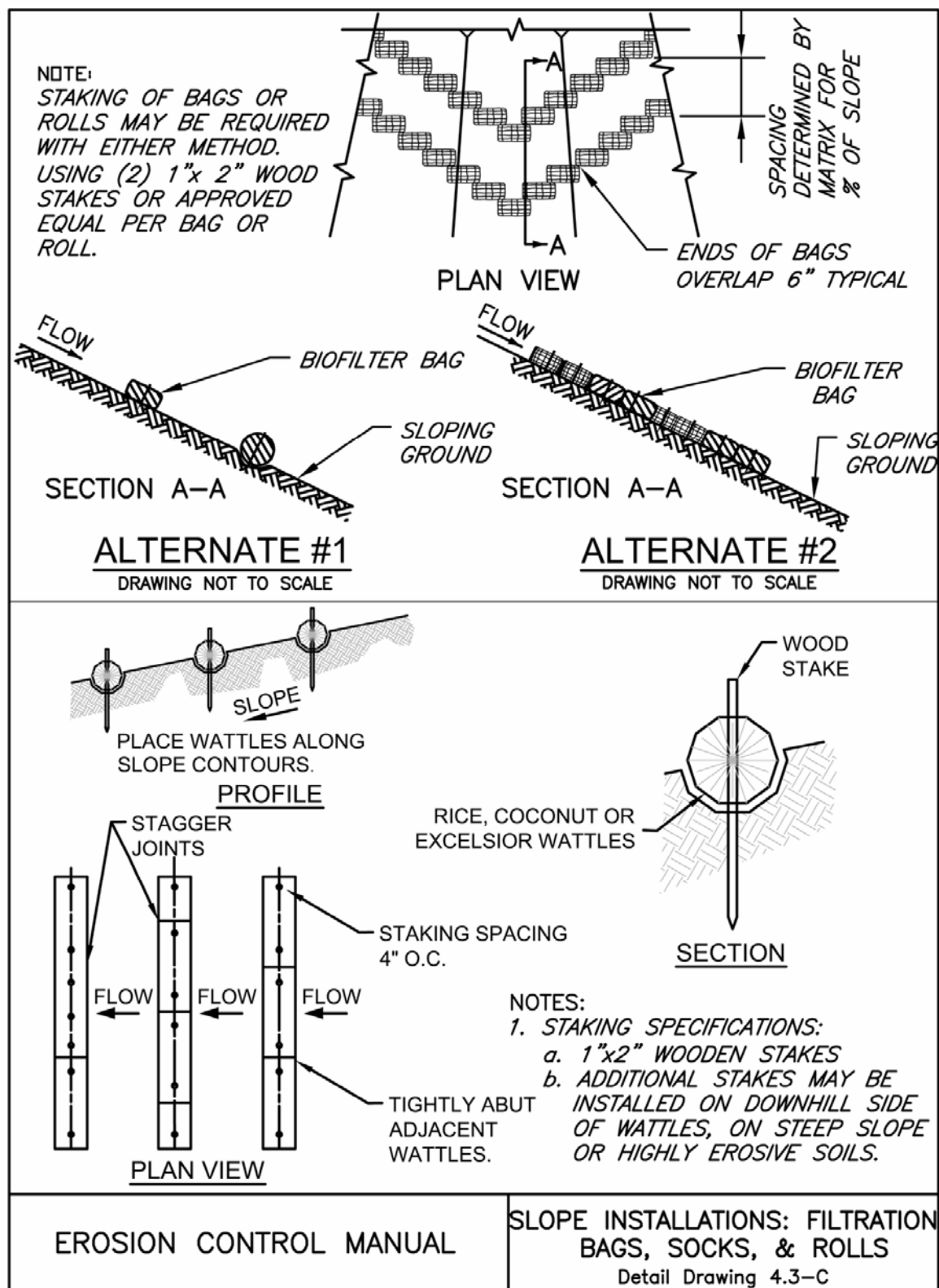
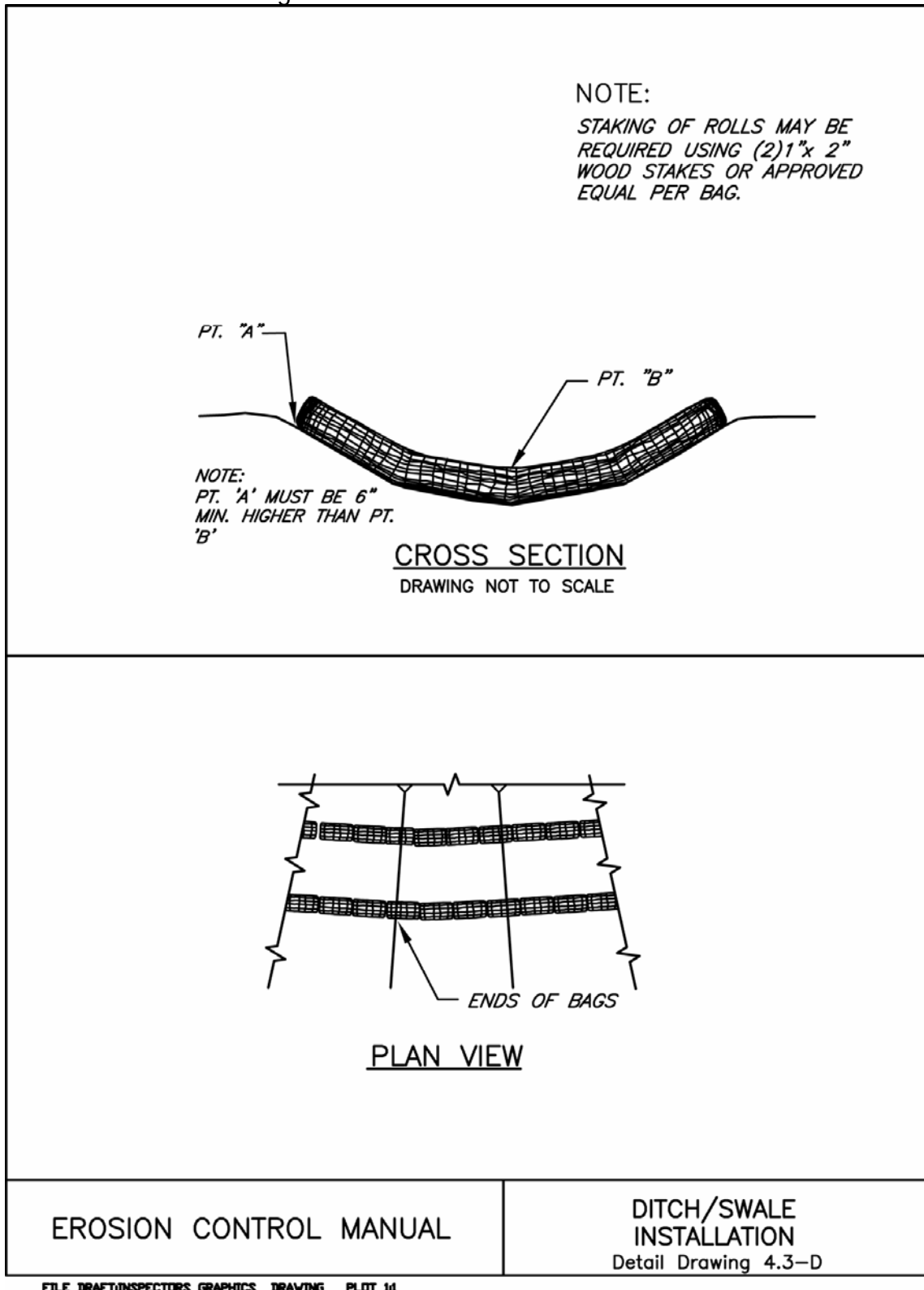


Figure 4.3-D Ditch/Swale Installation



4.3.4 Fiber Rolls and Wattles

Definition

Fiber rolls are circular, dense, vegetated fiber tubes that detain sediments and runoff flows. They are commonly made of rice and coconut fibers and can provide a planting medium for plug or potted plants. Wattles are plastic or rope mesh rolls that are usually filled with straw. These systems come in various lengths and are a good alternative to bag and sock products.

Purpose

To minimize the transport of sediment by providing a temporary physical barrier to sediment and reducing runoff velocities. To help stabilize the ground surface and provide a bed for planting. To shorten the length of slopes.

Conditions Where Practice Applies

- As a check dam in newly constructed or existing drainage ditches and/or swales.
- As flow control, by splitting up the length of slopes.
- Use weighted wattles to control sediment on paved surfaces.
- On the upslope or downslope sides of a sediment fence line.

Shall Not Be Used

- In high-flow areas.

Design Criteria/Specifications

- See Figures 4.3-B, 4.3-C, and 4.3-D for detail drawings.
- Fiber rolls are biodegradable and composed of weed-free vegetative materials.
- Stakes shall be installed as shown in the notes on Figures 4.3-C, and 4.3-D.

Maintenance Specifications

- Fiber rolls shall be inspected daily.
- Sediment depth shall not accumulate to more than one-third the height of the fiber roll.
- Sediment shall be removed or re-graded onto the slope, or new fiber rolls shall be installed uphill of sediment-laden barriers.

Removal Specifications

- Fiber rolls may be left onsite as a semi-permanent, biodegradable landscape feature.

Installation Tips

- Use fiber rolls up slope or down slope silt fence to provide added support to the toe of the fence.
- Maintenance is critical. Remove sediment buildup, and replace or add additional fiber rolls when one-third of capacity is full.
- Check remaining capacity often, since high flows can limit performance and damage rolls.
- Best used in low-exposure/low-sediment load areas.
- Check placement and performance often to avoid impacts from vehicle damage and/or vandalism.
- Ensure that no gaps exist under or between rolls that could bypass flows. Overlap fiber rolls and wattles whenever possible.
- Place sandbags over wattles to improve ground contact on impervious surfaces, or use manufactured weighted wattles.

Signs of Failure

Symptoms	Causes	Solutions
Concentrated runoff or sediment flows are coming around or under rolls.	<ul style="list-style-type: none"> • Insufficient materials. • Insufficient stake-down during installation. 	<ul style="list-style-type: none"> • Add additional materials and align to contain flows. • Reinstall with proper staking and entrenchment.
Sediment is overwhelming rolls.	<ul style="list-style-type: none"> • Lack of upslope BMPs. • Inadequate maintenance. 	<ul style="list-style-type: none"> • Add erosion prevention or other sediment control BMPs. • Clean sediment from behind bags or rolls.

4.3.5 Vegetated Buffers

Definition

Vegetated buffers are swaths of preserved or established vegetation that act as perimeter controls for a project site. The rooted vegetation holds soils, acts as a windbreak, and filters runoff that may leave the site. Vegetation shall be at least 1 inch in height and provide 80 percent ground coverage. Vegetated buffers shall be outlined with orange construction fencing before any ground-disturbing activity. Silt fence shall not be used in place of construction fencing for this purpose.

Purpose

To minimize offsite soil movement offsite by wind or surface runoff. May act as a supplemental measure to sediment barriers or silt fence.

Conditions Where Practice Applies

- A vegetated buffer is appropriate for use with other measures, rather than as a stand-alone facility. Vegetated buffers can provide “polishing” of water before it discharges to a drainageway. They are also helpful in controlling erosion on long slopes. Buffers are best created or preserved as native, high-root-mass, dense-foliage vegetation. Blackberries do not make good erosion control buffers.
- Before creating a temporary site control buffer, consider placement of permanent site vegetation. There may be an opportunity to install permanent site vegetation areas during construction to act as temporary sediment control buffers.

Shall Not Be Used

- Protected riparian areas and environmental resource sites (e-zones) shall not be used as a buffer without specific permission from the City.

Design Criteria/Specifications

- See Figure 4.3-E for detail drawing.
- For preservation buffers, designate areas of no disturbance. Clearly mark these areas with flags, fencing, or other visible methods. Ensure that all site workers understand the meaning and use of these areas.

- A vegetated buffer may be approved as an alternative to a sediment barrier at the toe of the site slopes if the buffer meets all of the following criteria:
 - The buffer is an undisturbed grassy area or is covered with other approved dense vegetation.
 - The buffer is downhill and in the drainage path of the construction/disturbed area.
 - No concentrated flows from the disturbed site enter the buffer.
 - The buffer area is owned by the applicant or approved for such use in writing by the owner.
- Buffers shall be sized according to the table below:

Site Location	Minimum Buffer Width
Infill or flat site (< 10% slope) with less than 100 feet of slope length.	10 feet
Adjacent to waterways or other natural resources	50 feet, 20 % of the slope length, or as per environmental, greenway or other zoning requirements, whichever is greater.
Other slopes	10 feet or 20% of the slope length, whichever is greater.

Maintenance Specifications

- Maintenance is critical. Sediment depth shall not accumulate to more than 2 inches across the buffer. Sediment shall be removed, and replaced on active site or reused offsite. Removal of sediment shall not remove groundcover vegetation in the buffer. Any exposed soils shall be immediately reseeded or revegetated, and another form of erosion and sediment control BMP shall be used until the dense vegetation is reestablished.

Removal Specifications

- Buffers are usually permanent features that are preserved prior to construction or are areas of permanent landscaping. Temporary buffers shall be removed before placement of final permanent groundcover and shall be the last action taken on the construction site before perimeter controls are removed.

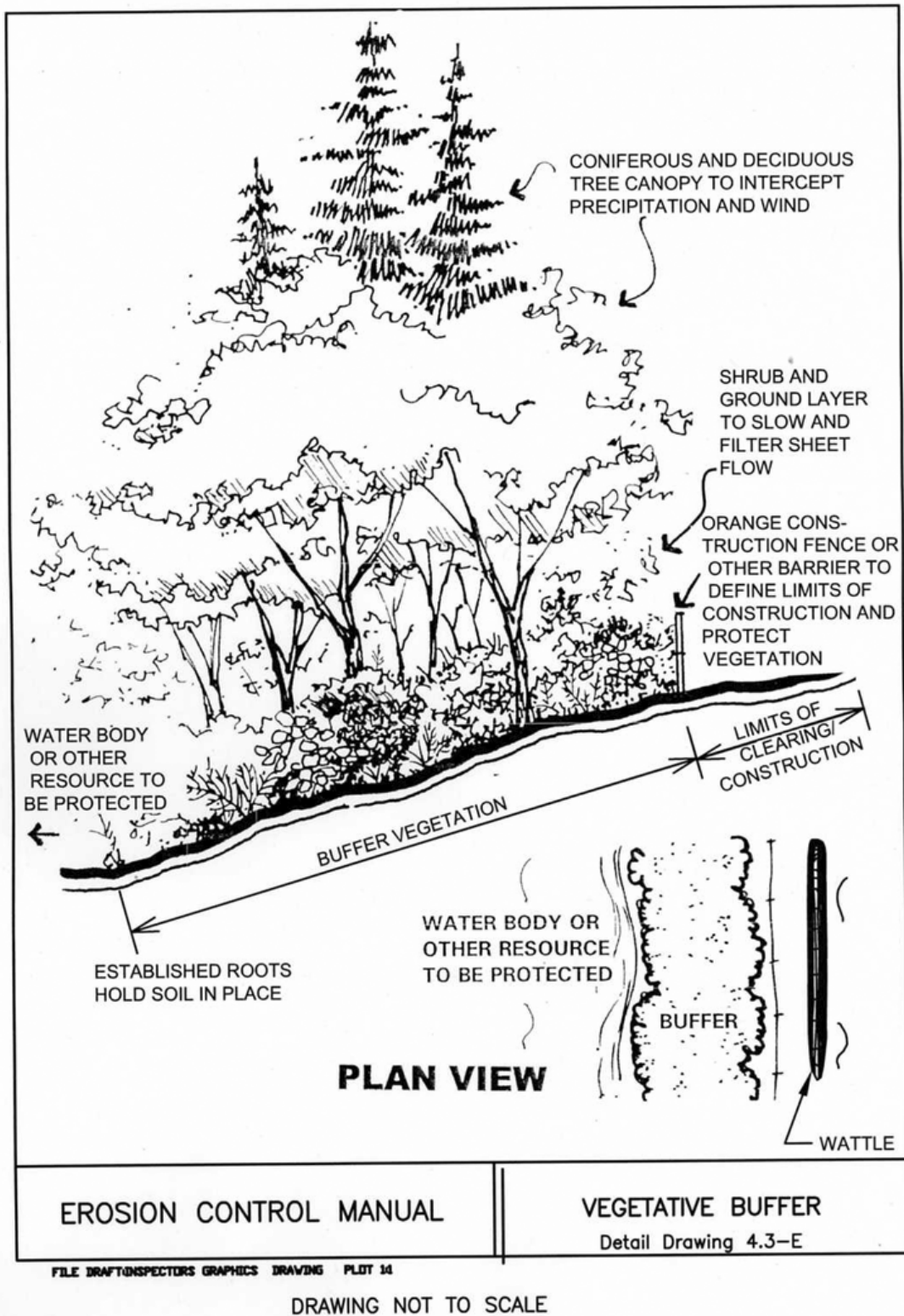
Installation Tips

- Ensure that the buffer has densely rooted groundcover materials that will stay in place during sediment removal.
- Buffers are best used in low-exposure/low-sediment load areas.

Signs of Failure

Symptoms	Causes	Solutions
Concentrated runoff or sediment flows are discharging from buffers.	<ul style="list-style-type: none">• Insufficiently sized buffers.• Flow is concentrating and not dissipating across the buffer.	<ul style="list-style-type: none">• Add additional width/depth to buffer area.• Install or repair flow-spreading devices to ensure sheet flow across the buffer.• Provide additional sediment control BMPs prior to discharge through buffers.

Figure 4.3-E Vegetated Buffer



4.3.6 Storm Drain Inlet Protection

Purpose

To minimize sediment entering storm drain systems or catch basins prior to permanent stabilization of disturbed areas. Inlet protection may consist of inlet barriers, inlet inserts, or a combination of both.

Inlet barriers surround the inlet to prevent sediment from entering. Barriers can be made from plastic, geotextiles, or aggregate materials. Inlet inserts are devices designed to hang down into a catch basin or inlet and trap sediment and/or filter construction and stormwater flows entering the inlet. Inserts can include bags, racks, baskets, or other devices made from filter fabric, wire mesh, metal plates, various types of plastic products, and combinations of these and other materials.

Conditions Where Practice Applies

- Where interior site or adjacent storm drain systems are built or operational before permanent stabilization of the disturbed drainage area.
- Adjacent to and immediately downhill of utility-type construction in existing paved areas with catch basin drainage.
- Any field or street inlet or catch basin that may receive construction-related site runoff.

Shall Not Be Used

- Alone without other site control BMPs.
- In high-traffic or high-flow areas.
- Straw bales shall not be used for catch basin protection.

Design Criteria/Specifications

Inlet Barriers

- Figures 4.3-F and 4.3-G show design criteria and specifications for two recommended methods of storm drain inlet barriers.
- Inlet barrier methods include protection blocks, inlet pillows, fiber rolls or wattles, and sand bags.
- Berms may be required to direct drainage to flow through the filters and prevent bypassing of the inlets.

- Wrapped grates shall have fabric ends secured under the grate in a way that does not allow the grate to lift and runoff flows to bypass the inlet. This protection technique is allowed only for short-term use (less than 24 hours) and for low-flow protection.
- Filter bags and socks shall be replaced at least every 3 months, and more often if necessary to maintain their effectiveness.
- Additional measures may be required to control flows, wash-over, and down-gradient flooding on sloping sites.

Inlet Inserts

Inlet inserts shall be used with additional upslope BMPs, including sweeping of surfaces; they are not effective when used alone. Inserts shall be installed per the manufacturer's instructions and shall meet the following criteria:

- Devices shall be installed as a point protection or in series as a perimeter sediment control before any site grading activity.
- Installation shall not block flows from filtering into the inlet or catch basin.
- Devices shall be installed without protruding parts that could be a traffic, worker, or pedestrian hazard.
- Retrieval edges, cords, bars, chains, or other mechanisms shall be flagged or marked for retrieval under submerged conditions.
- Curb inlet protection devices shall be required in addition to inlet inserts where recessed curb inlets are present.

Maintenance Specifications

Inlet Barriers

- At no time shall sediment be allowed to accumulate to more than one-third the height of a storm drain inlet protection BMP. Sediment shall be removed and inlet protection BMPs restored as needed to maintain their sediment trapping and filtering capability.
- Catch basins shall be cleared of any sediment or debris that bypassed the barrier and insert during site development.

Inlet Inserts

- Inlet devices shall be inspected after every major rainstorm. During dry weather, devices shall be inspected at least every 2 to 3 weeks.

- Like other sediment control devices, inserts shall be maintained when sediment consumes one-third of the actual device storage area or design storage capacity.
- Replacement shall be per manufacturer's instructions or when the device no longer drains. At no time shall devices be punctured or otherwise modified to bypass water flows.

Removal Specifications

- Inlet protection shall be the last BMP removed from the site after construction and cleanup are completed and all erosion and sediment control BMPs are removed.
- All inlet insert devices shall be removed after construction is completed. Failure to remove this obstruction is a violation of the City's sewer code.

Installation Tips

- For field inlets using silt fence protection (see Figure 4.3-A), use multiple rows of fencing to enhance protection from construction vehicles.
- Ensure that overlap joints in silt fence fabric pieces are appropriately welded or wrapped.
- Consider use of check dams in the gutter drainage area upslope of inlet devices to enhance sediment removal.

Signs of Failure

Symptoms	Cause	Solution
System not filtering.	<ul style="list-style-type: none">• Fabric has become clogged.	<ul style="list-style-type: none">• Remove and replace filter materials. Reuse if material is suitable.• Provide additional upslope erosion prevention or sediment control BMPs.

Figure 4.3-F Inlet Protection Measures

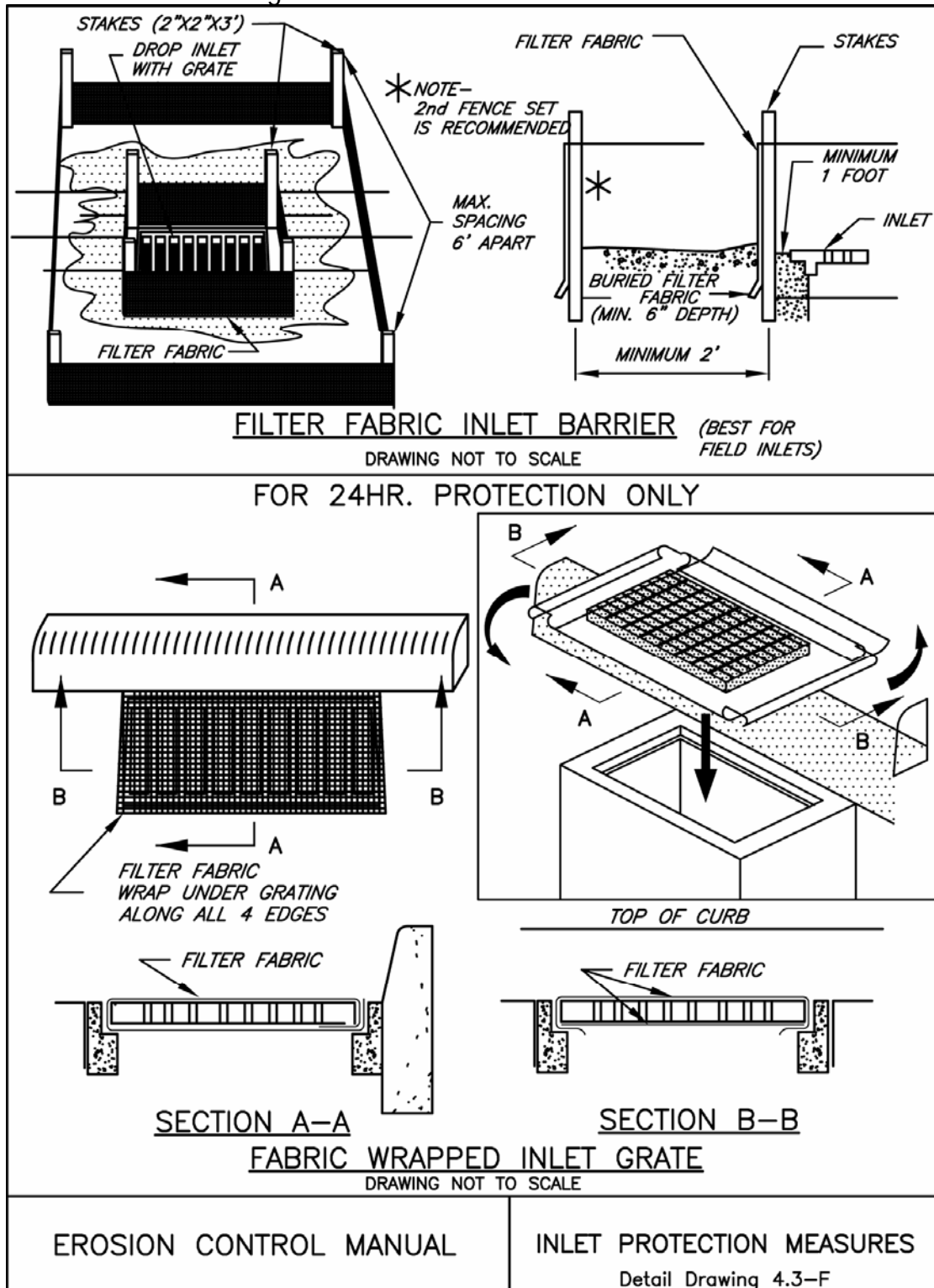
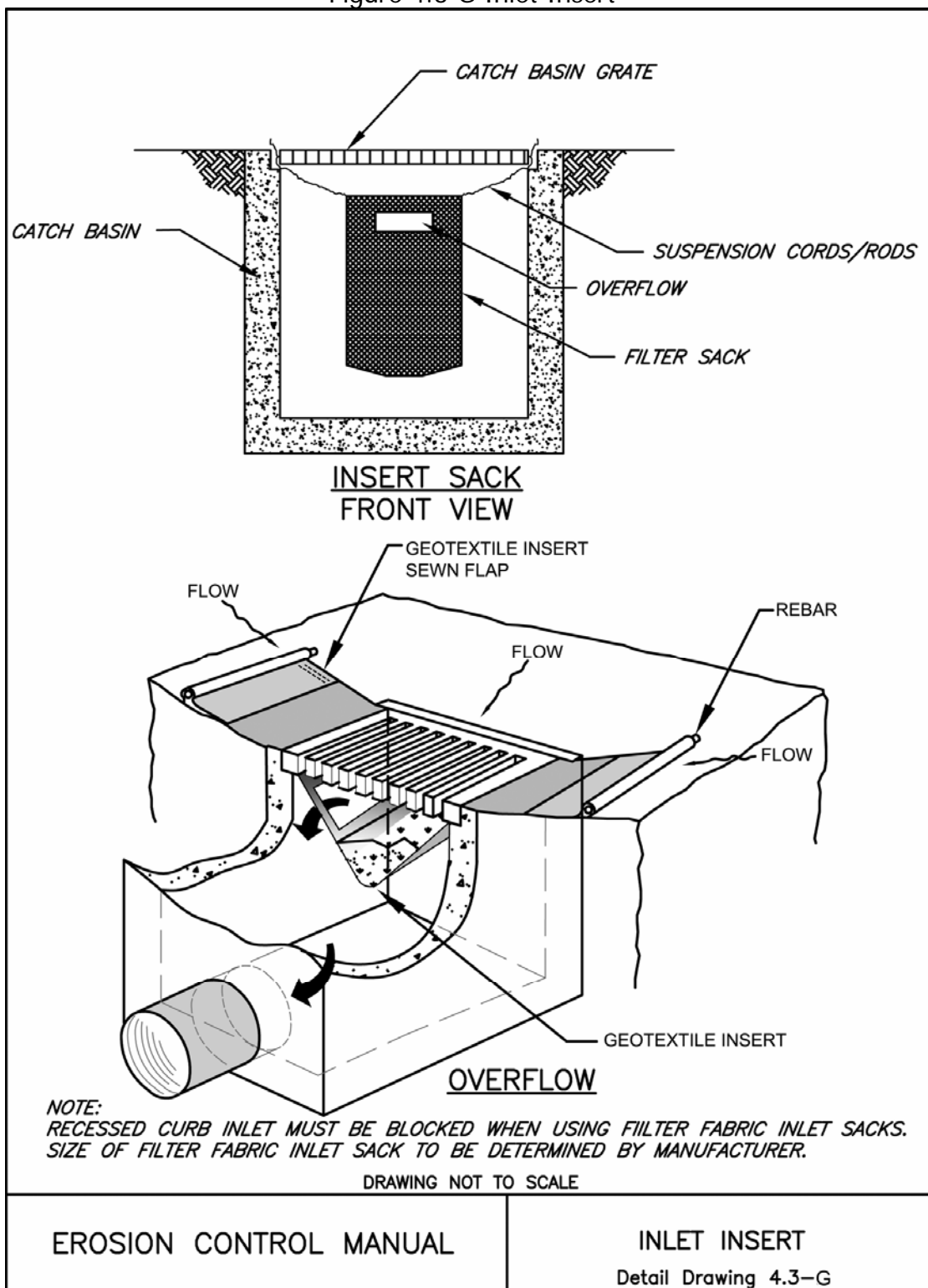


Figure 4.3-G Inlet Insert



NOTE: REMOVE INSERT AT PROJECT COMPLETION

4.3.7 Filtration Berms

Definition

A variety of filtration media can be placed around the perimeter of the construction site as a sediment control berm, with or without a confining sock or bag. These berms are most commonly created of gravel and compost. They are usually continuous berms placed by machine.

Purpose

To act as a secondary perimeter sediment control measure.

Conditions Where Practice Applies

- Around the perimeter of a construction site.
- Around the base of a stockpile.
- As a check dam or slope flow dissipater.

Shall Not Be Used

- Alone without other site control BMPs.
- In high-traffic or high-flow areas.
- On steep slopes.

Design Criteria/Specifications

- See Figure 4.3-H for detail drawing.
- These media shall be placed per the supplier's specification. They shall generally follow the following design criteria:
 - Width: Usually 6 to 12 inches, depending on the angle of repose of the material used.
 - Height: Usually 4 to 8 inches, depending on the angle of repose of the material used.
 - Overlap: If not continuous, berms shall overlap at least 8 inches to the upslope side of the berm (the side closest to the soil disturbance).

Maintenance Specifications

Berm materials can get clogged just like any other filtration media.

- Remove sediment from the upslope side of the berm when sediment reaches no more than one-third the height of the berm.
- Turn over or rake the filtration media surface to break up clogging by sediments and other materials.

Removal Specifications

- Filtration berms shall be the last BMP removed from the active construction site after construction is completed.
- Filtration media shall be washed and reused or, depending on the materials, spread and reused onsite.

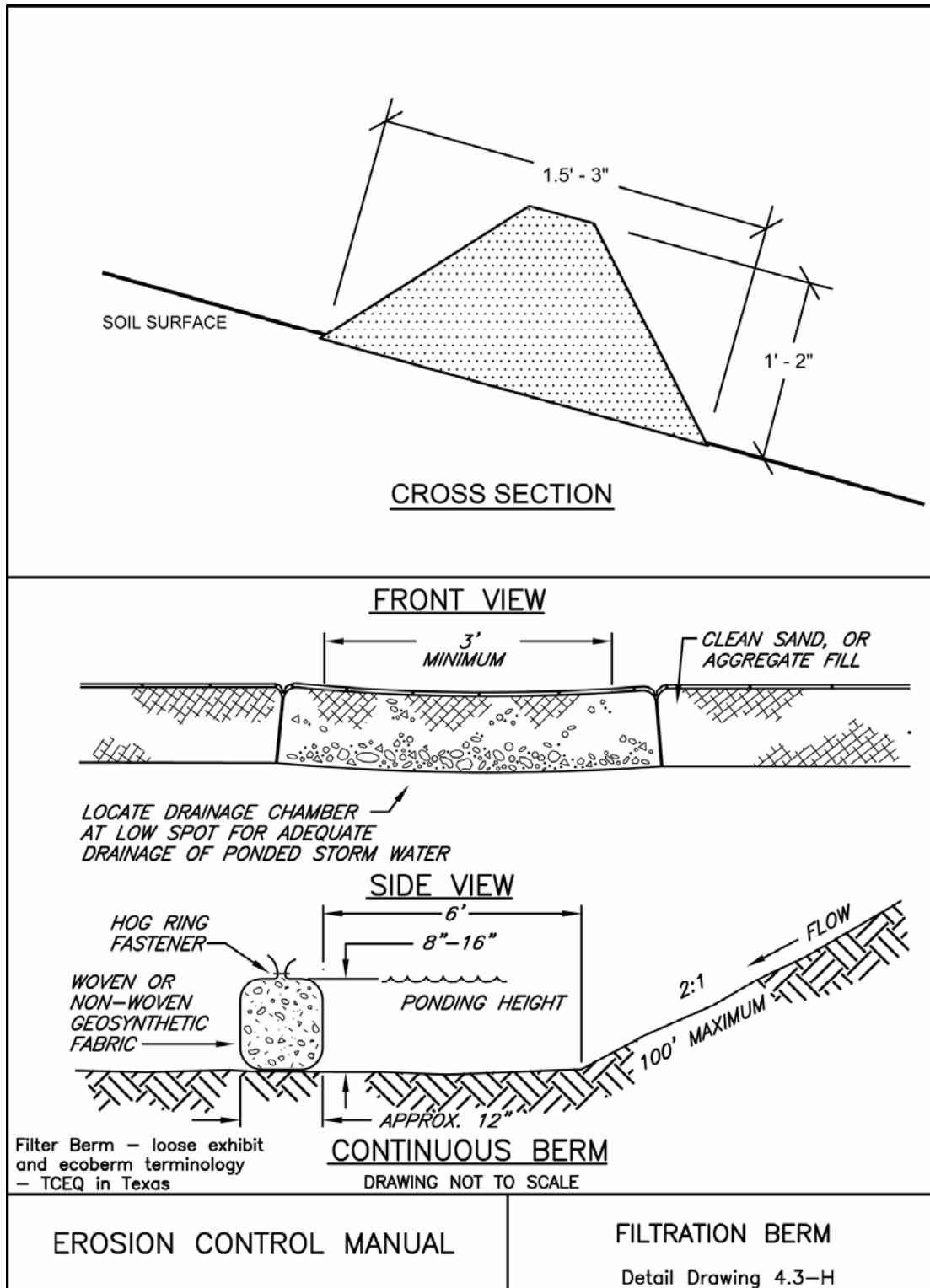
Installation Tips

- Install these systems using a designated installation machine specifically designed for that purpose. It is extremely difficult to install these systems by hand and meet the specification that requires a continuous berm.
- Use these systems in conjunction with erosion prevention BMPs for best viability.
- Install these systems after initial site clearing.

Signs of Failure

Symptoms	Cause	Solution
System not filtering.	<ul style="list-style-type: none">• Media has become clogged.	<ul style="list-style-type: none">• Remove and replace filtration media. Clean and reuse if material is suitable.• Provide additional upslope erosion prevention or sediment control BMPs.

Figure 4.3-H Filtration Berm



4.4 STORMWATER CONTROL BMPS

Stormwater control is vital for preventing erosion. The following BMPs describe methods to convey, divert, treat, and otherwise control stormwater flow rates and volumes. Stormwater control BMP sizing can be complex and runoff volumes and rates difficult to predict. It is recommended that a registered professional engineer be consulted on all stormwater control facility designs. For some stormwater controls, such as permanent ponds, plans prepared by a registered professional engineer may be required.

4.4.1 Interceptor Dikes and Swales

Definition

Dikes are temporary low ridges or dams, and swales are shallow ditches. In this application, they run across slopes to catch and redirect stormwater runoff.

Purpose

To intercept and/or divert storm runoff from onsite and offsite drainage areas. To convey runoff from above unprotected slopes or a disturbed site and direct it to a sediment trap, pond, or other approved stabilized outlet. Dikes and swales may be installed as permanent site drainage control features, while providing conveyance of temporary development flows.

Conditions Where Practice Applies

- To divert drainage around or away from work areas.
- Where the volume and velocity of runoff from disturbed slopes is erosive and must be reduced or redirected. When an interceptor dike or swale is placed above a disturbed slope, it collects and conveys flows away from the slope, reducing the volume of water reaching the disturbed area.
- To direct site runoff to a sediment trap or pond, if applicable.

Design Criteria/Specifications

- See Figure 4.4-A for detail drawing.
- Flows from the drainage areas to be collected and/or conveyed by the dike or swale shall be estimated.
- Multiple dikes and swales may be needed to convey flows. The purpose of the dikes and swales is to prevent detachment of sediment and to reduce stormwater flows. Their spacing may need to be adjusted in the field to achieve adequate performance. As a guideline, dikes and swales shall have the following maximum horizontal spacing on slopes:

Slopes	Dike/Swale Spacing (feet)
Less than 5%	300
5-10%	200
10-25%	100
25-50%	50

Source: *State of Virginia Erosion and Sediment Control Manual*, 1994

- Maximum grade within interceptor swales shall be 5 percent, and swales shall provide positive drainage to outlets. Erosion protection materials shall be used on exposed soils prior to receiving flows and shall be specified in submittal plans. Such cover may include grass, rock, or erosion blankets. Check dams shall be used to control stormwater flows if design varies from the maximum grade or spacing requirements.
- Grades for drainage parallel to interceptor dikes shall be between 0.5 and 1.0%, with a maximum flow velocity of 2 fps (feet per second).
- Dike material shall be compacted to 90% of the maximum dry density determined in accordance with ASTM D1557 (Modified Proctor method).
- Intercepted runoff shall be directed to a stabilized area such as a pond, trap, or other holding area. This diversion shall be designed so that no erosion occurs from the movement of the additional water volume and flow rate.
- The upslope side of interceptor dikes shall provide positive drainage to the dike outlet. Energy dissipation BMPs shall be provided as necessary to minimize erosion at dike outlet.
- Construction traffic over dikes and swales shall be minimized. When access across or into facilities is unavoidable, repairs shall be made as necessary.
- Where necessary, underdrains shall be provided to ensure diverted water does not cross traffic areas.

Maintenance Specifications

- Inspect after every major rainstorm for side and bottom inlet and outlet scour.
- Remove sediment and other debris when one-third of the conveyance or design storage capacity is met.
- Repair any rills or gullies over 2 inches in depth, and provide additional flow control upslope of the repair.

Removal Specifications

- Temporary dikes and swales shall be graded out at the completion of construction, when permanent vegetation has been established.
- Permanent stormwater management dikes and swales may be used to control runoff during construction, but must be refurbished before site closeout.

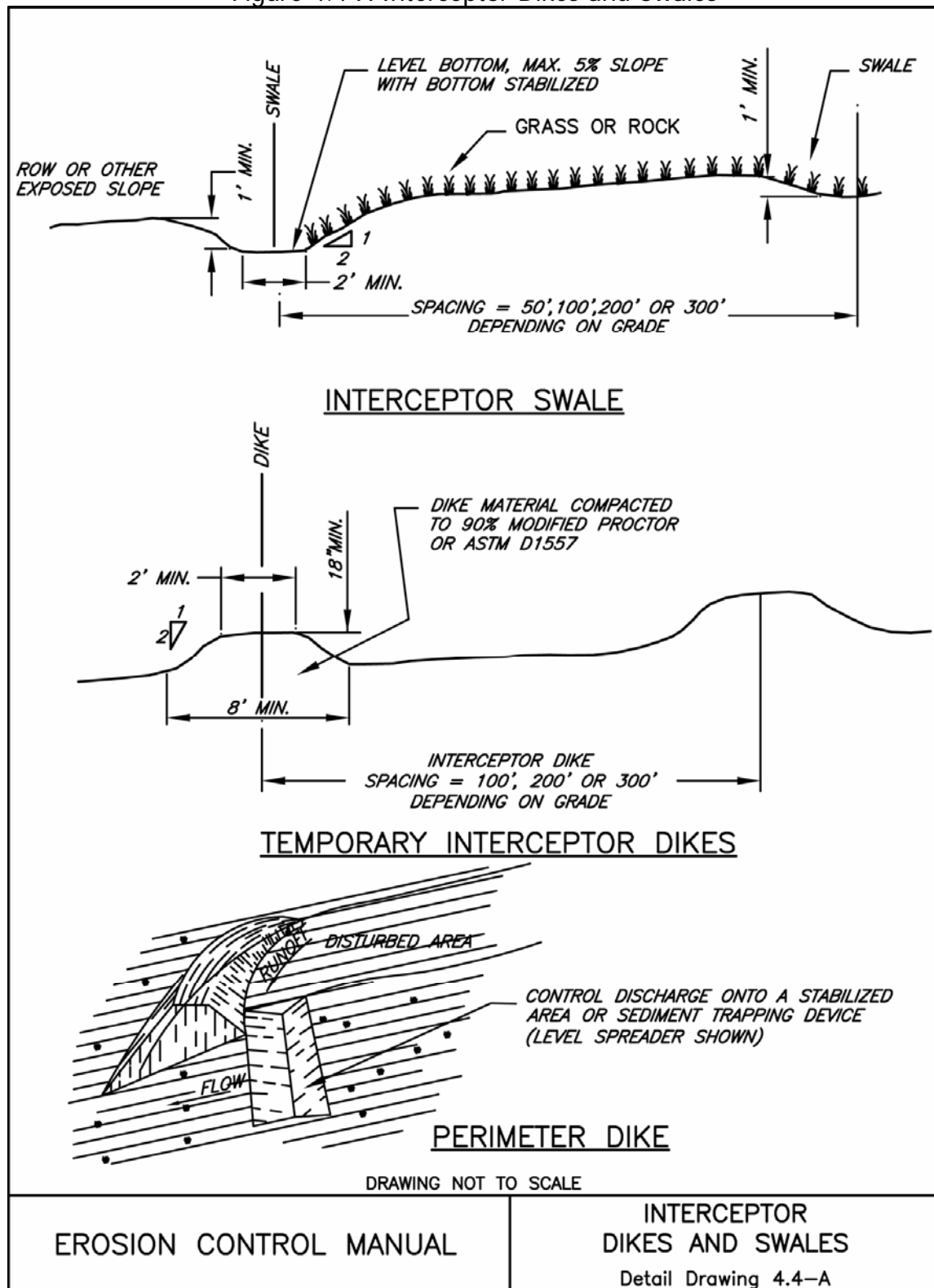
Installation Tips

- Consider installing the dike or swale as a permanent water quality or conveyance feature for post-development runoff control.
- Establish the dike or swale layout early in the site design and development process, ideally at the time of mass grading.
- Site swales and dikes on terraces of steep slopes and on contour. Allow at least a 10-foot width in the terrace for maintenance access.
- Visibly mark locations of dikes and swales with poles or fencing to help protect them from construction traffic.
- Use check dams or other BMPs to control flow rate within dikes and swales. Ensure that these controls are designed to avoid blowout.

Signs of Failure

Symptoms	Cause	Solution
Erosion from dike or swale.	<ul style="list-style-type: none"> • Flows are flushing sediments out of the system. • Flows are eroding the dikes or swales themselves. 	<ul style="list-style-type: none"> • Install additional check dams or energy dissipaters. • Add additional vegetative, blanket, or armoring cover to the sides and bottom of the swale or dike.

Figure 4.4-A Interceptor Dikes and Swales



FILE DRAFT\INSPECTORS GRAPHICS DRAWING PLOT 14

4.4.2 Check Dams

Purpose

To reduce the velocity of concentrated flows in swales, dikes, gutters, or ditches. Check dams reduce erosion and provide for sedimentation of suspended soil particles and other site pollutants. Check dams shall not be used as permanent installations unless sufficiently keyed into side slopes.

Conditions Where Practice Applies

- In existing or disturbed ditches, dikes, and swales to reduce velocities and erosion.
- In interior site ditches, dikes, or swales that convey runoff from disturbed areas.
- In road gutters and against curbs to reduce runoff velocities.

Shall Not Be Used

- On slopes > 30 percent.
- Across natural channels, unless permitted by a state or federal resource protection agency.

Design Criteria/Specifications

- See Figure 4.4-B for detail drawing.
- Check dams shall be constructed of rock, fiber rolls, triangular silt dike, filled socks, or filled bags (e.g., sand bags). Check dams may also be constructed of wood, plastic, or straw if approved by the City.
- A 1-foot-deep trench shall be constructed immediately upstream of check dams for storage of settled sediment.
- A 6-inch spillover section shall be provided within the center of the check dam.
- Check dams shall be designed to have an armored scour pool on the downstream side of the check dam. The armoring shall be at least 2 inches thick and shall extend one-half of the width of the entire channel downstream from the dam itself. For example, if a channel is 10 feet wide, there is a 5-foot-long section of armoring downstream from the center overflow area of the check dam.
- Rock check dams shall be constructed of 4- to 6-inch gabion rock. The rock shall be placed by hand or mechanical placement in a manner that completely covers the width of the ditch or swale.

Maintenance Specifications

- Check dams shall be checked for sediment accumulation after each major rainfall. Sediment shall be removed upon filling one-third of the trapping capacity.

Removal Specifications

- Temporary erosion and sediment control check dams shall be removed when drainage is diverted to the permanent conveyance system or before construction site closeout. In no situation shall the same check dam remain in place for a period of over 2 years without significant rehabilitation.
- Check dams can be designed as permanent features in drainage channels.

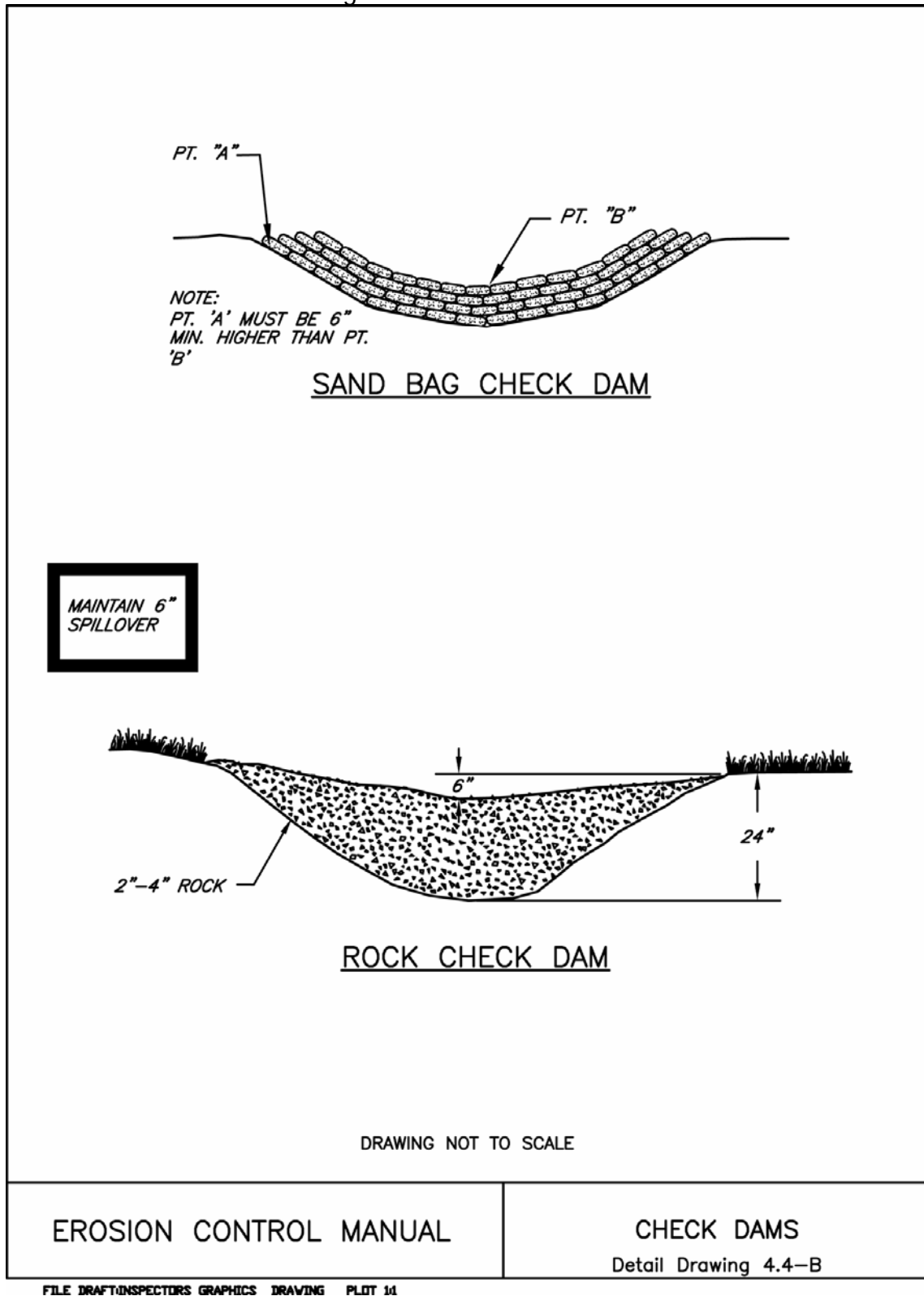
Installation Tips

- Ensure that check dams are adequately keyed into side slopes to withstand flows and prevent washout at ends.
- Ensure that materials make adequate contact with or are imbedded in the channel bottom.
- Determine the method of maintenance for sediment removal from behind dams before placement. Ensure there is sufficient area for equipment access and materials collection.

Signs of Failure

Symptoms	Cause	Solution
Check dam has blown out or material is displaced.	<ul style="list-style-type: none"> • Materials not adequately anchored. • Insufficient number or too much space between check dams. 	<ul style="list-style-type: none"> • Replace materials with adequate anchoring. • Install additional check dams or maintain upstream check dams.
Sediment is released from system.	<ul style="list-style-type: none"> • Upstream check dams are at or over capacity for sedimentation. • Flows are scouring channel sides or bottom. 	<ul style="list-style-type: none"> • Maintain check dams. • Add additional check dams or other energy dissipaters. • Add soil protection BMPs, such as vegetation, blankets, or armoring.

Figure 4.4-B Check Dams



4.4.3 Pipe Slope Drains

Definition

Pipe slope drains are temporary conduits, usually of flexible piping, that are placed from the top to the bottom of the slope to contain and convey runoff. Pipe slope drains prevent erosion by preventing contact between bare slope soils and runoff.

Purpose

To convey concentrated runoff down steep slopes without causing erosion or saturating slide-prone soils.

Conditions Where Practice Applies

- Where concentrated runoff must be conveyed down a slope or around a work area to prevent erosion. Pipe slope drains convey clean water from above a work area to below the work area.
- To be combined with interceptor dikes or swales to convey stormwater from the entire drainage area above a slope to the base of the slope.

Shall Not Be Used

- Over natural channel features (unless authorized/permitted).
- On slopes < five percent.

Design Criteria/Specifications

Proper installation, pipe sizing, and entry flow control are key to the success of pipe slope drains. Failure of this type of facility usually results in severe erosion.

- See Figure 4.4-C for detail drawing.
- The collection and conveyance system shall be designed to handle site runoff generated from a 10-year, 24-hour peak flow event. In general, minimum recommendations for pipe sizing are as specified in the table below:

Recommended Pipe Slope Drain Size

Maximum Drainage Area (acres)	Minimum Pipe Diameter (inches)
0 – 0.5	12
0.5 – 0.75	15
0.75 – 1.0	18

Notes:

An engineered system is required for areas of 1.0 acre and larger.

The above numbers are recommendations only; they may or may not be adequate for your site.

Many factors affect pipe slope drains and must be considered in their design. The City accepts no responsibility for the non-engineered design of these facilities should they be used and fail to meet other requirements of this manual and the City Code.

- Pipe slope drains shall be constructed from heavy-duty flexible materials such as non-perforated, corrugated plastic pipe or specifically designed flexible tubing.
- Pipe slope drains shall be placed directly on the ground or buried under the surface. The inlet/entrance to the pipe shall be a standard flared end section metal toe plate or approved equal. This plate shall be sized to fit flows and pipe opening (6 inches minimum). The slope of the pipe entrance shall be at least 3 percent and oriented at an angle to collect flows.
- The soil around and under the pipe entrance shall be thoroughly compacted to prevent undercutting. In addition, exposed soils shall be protected to prevent gully erosion from occurring beneath the pipe. If the pipe slope drain will be in place for more than 3 months, vegetation shall be established to protect the soils.
- The height of any dike, berm, or barrier shall be at least 1 foot higher at all points than the top of the inlet pipe.
- All pipe sections shall be watertight and anchored with hold-down grommets and/or stakes with cross-wire straps. Anchors shall be placed at intervals not to exceed 10 feet.
- Pipe slope drains shall discharge into an approved disposal facility. The area below the outlet shall be stabilized with armoring or a metal toe plate. Metal toe plates shall be sized to fit flows and pipe openings (6 inches minimum). Other stormwater flow and water quality control requirements and/or permits may be required for approved disposal, depending on project location.
- If the pipe slope drain is conveying sediment-laden water, BMPs shall be used to trap the sediment in the runoff before the water is conveyed offsite.

Maintenance Specifications

- Inlet and outlet points shall be checked daily, especially after any storm events. The inlet shall be free of undercutting, and no water shall be going around the pipe inlet. If erosion problems exist anywhere along the slope drain, any holes, rills, or gullies shall be filled with soil, compacted, and protected as necessary with appropriate materials such as erosion control blankets or rock.

Removal Specifications

- Temporary pipe slope drains shall be removed only after slopes have been stabilized, a permanent collection and conveyance system has been established, or the conveyance of runoff down the slope is no longer needed.
- Brush pack and fascine slope drains can be used for permanent control measures.

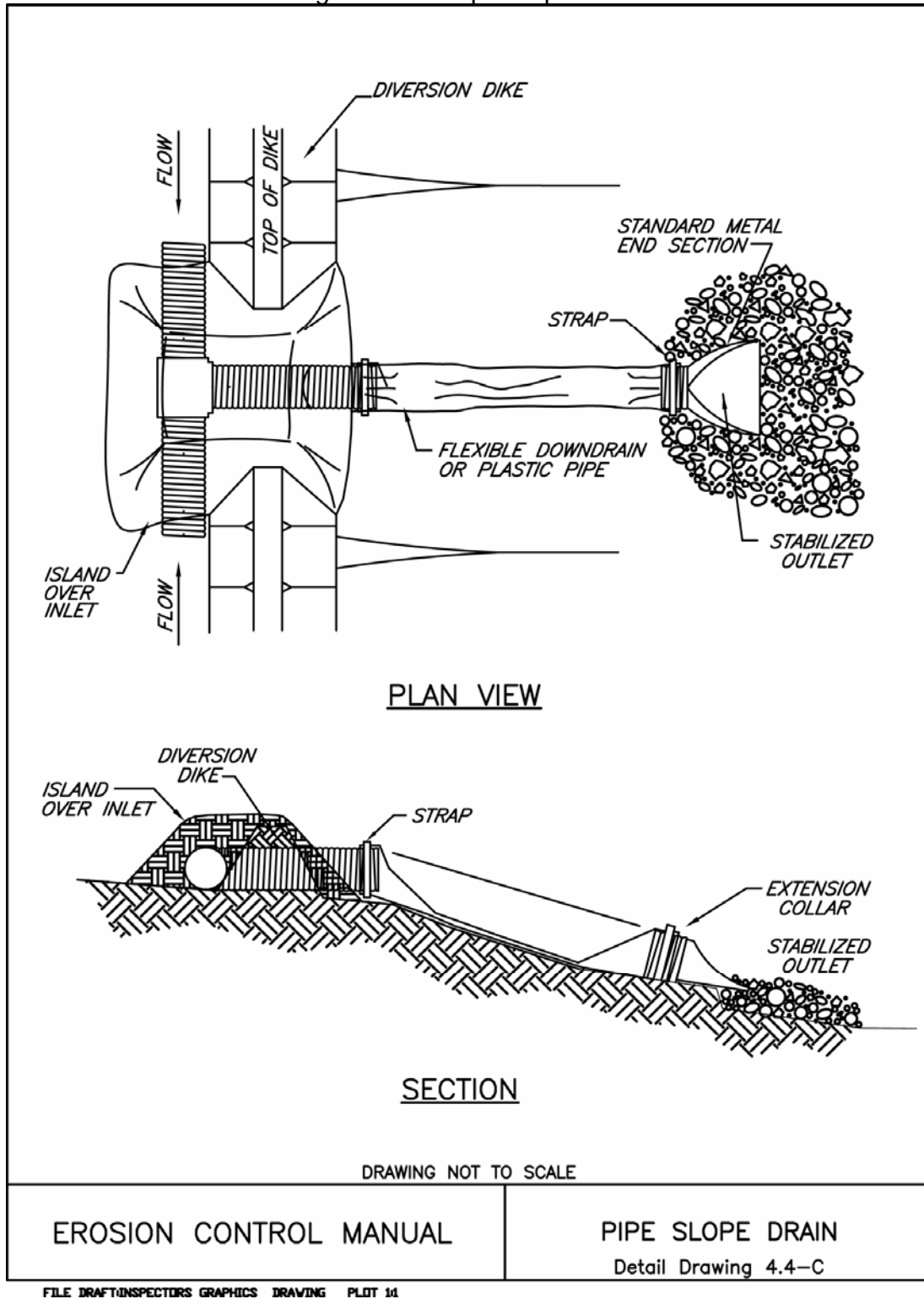
Installation Tips

- Ensure the flared inlet and outlet are keyed into the ground and secured so flows do not bypass or pond at these locations.
- Use a dike or swale along the top of the slope to direct flows to the pipe slope drain inlet.
- Use multiple drains for large slope areas.
- Provide enhanced armoring at the bottom of all outlets.

Signs of Failure

Symptoms	Cause	Solution
Water is bypassing or undercutting inlet.	<ul style="list-style-type: none"> • Flared inlet is not keyed into the ground. • No systems collect and convey water to the inlet. • Inlet is undersized. • Inlet area is not compacted. 	<ul style="list-style-type: none"> • Re-establish flared inlet into the flow path. • Add dikes or swales to direct flow. • Recalculate the amount of expected flows, and upsize inlet and piping as necessary. • Re-compact the area around the inlet.
Pipe slope drain shifts on the slope.	<ul style="list-style-type: none"> • Drain is not secured to the ground. 	<ul style="list-style-type: none"> • Add additional strapping on sections of pipe. <p>Increase the depth of stakes.</p>

Figure 4.4-C Pipe Slope Drain



4.4.4 Stormwater Barriers

Definition

Stormwater barriers are a group of portable materials, including hay bales, triangular silt dikes, plastic dams, rock sack berms, and other materials, meant to impound stormwater and sediment-laden flows. These systems are often manmade, can be modular and therefore replaced by sections, and may have sediment-settling abilities. Some systems are also designed to dissipate flows.

Purpose

To block or divert stormwater or erosional flows from entering or exiting a site; to provide temporary impoundment of stormwater or erosion-laden flows.

Conditions Where Practice Applies

- As a dam for flows going offsite.
- For emergency flow diversion or flow blockage.
- Some products can be used to develop settling basins.
- Some products can act as inlet protection.

Shall Not Be Used

- Stormwater barriers shall not be used in streams and other drainage channels unless barriers are permitted for use to create a dry work area with flow channeled around the exterior.
- Straw bales shall not be considered as a means of filtering sediment and shall not be used alone (without other upland or perimeter control BMPs) except in emergencies. Straw bales shall not be used for catch basin protection, except in emergencies.

Design Criteria/Specifications

- See Figures 4.4-Da and b for detail drawings.
- Install manufactured products per manufacturer's instructions.
- For barriers with aprons, sink the first 4 inches of the apron on the upslope/upstream side into a trench and backfill.
- Determine if additional energy dissipaters are needed to control discharges.
- The maximum allowed length of slope before encountering a stormwater barrier is 100 feet. (Use the Revised Uniform Soil Loss Equation for guidance.)

Straw Bales

- Straw bales shall be standard 40- to 60-pound rectangular bales of weed-free grass, hay, or seed straw.
- Straw bales shall be keyed 2 to 4 inches into the existing ground.
- Stakes shall be wood and of the size shown on Figure 4.4–D, and shall be driven through bales and into the ground to a minimum depth of 12 inches.
- Avoid ground contact with baling wire or ties to prolong the longevity of the bales.

Maintenance Specifications

- Maintenance is critical. At no time shall sediment be allowed to accumulate more than one-third of the stormwater barrier's height. Sediment shall be removed or re-graded into the slope, or new lines of barriers shall be installed upstream of sediment-laden barriers.
- Check placement and performance often to avoid impacts from flows and/or vandalism.
- Check flow rates often, since high flows can limit performance and damage the barrier.

Note: More permanent sediment control (ponds, traps) and flow diversion structures (temporary swales) are preferred for long-term projects.

Removal Specifications

- Once the upslope area is stabilized, stormwater barriers shall be removed for disposal or reuse. Straw bales and other organic barriers may be reused onsite.
- Straw and other organic materials can be incorporated as mulch after completion of site work if approved by the City. Removal will necessitate a post-construction site visit.

Installation Tips

- Install per manufacturer's specifications.
- Some barriers may be good for use on impervious surfaces.

Signs of Failure

Symptoms	Cause	Solution
Concentrated runoff or sediment flows are coming around or under BMP.	<ul style="list-style-type: none">• Insufficient materials.• Insufficient stake-down during installation.	<ul style="list-style-type: none">• Add additional materials and align to contain flows.• Reinstall with proper staking and inset.
Sediment is overwhelming the barrier.	<ul style="list-style-type: none">• Lack of upslope BMPs.• Inadequate maintenance.	<ul style="list-style-type: none">• Add erosion prevention or other sediment control BMPs.• Clean sediment from behind bags or rolls.

Figure 4.4-D.a Stormwater Barriers

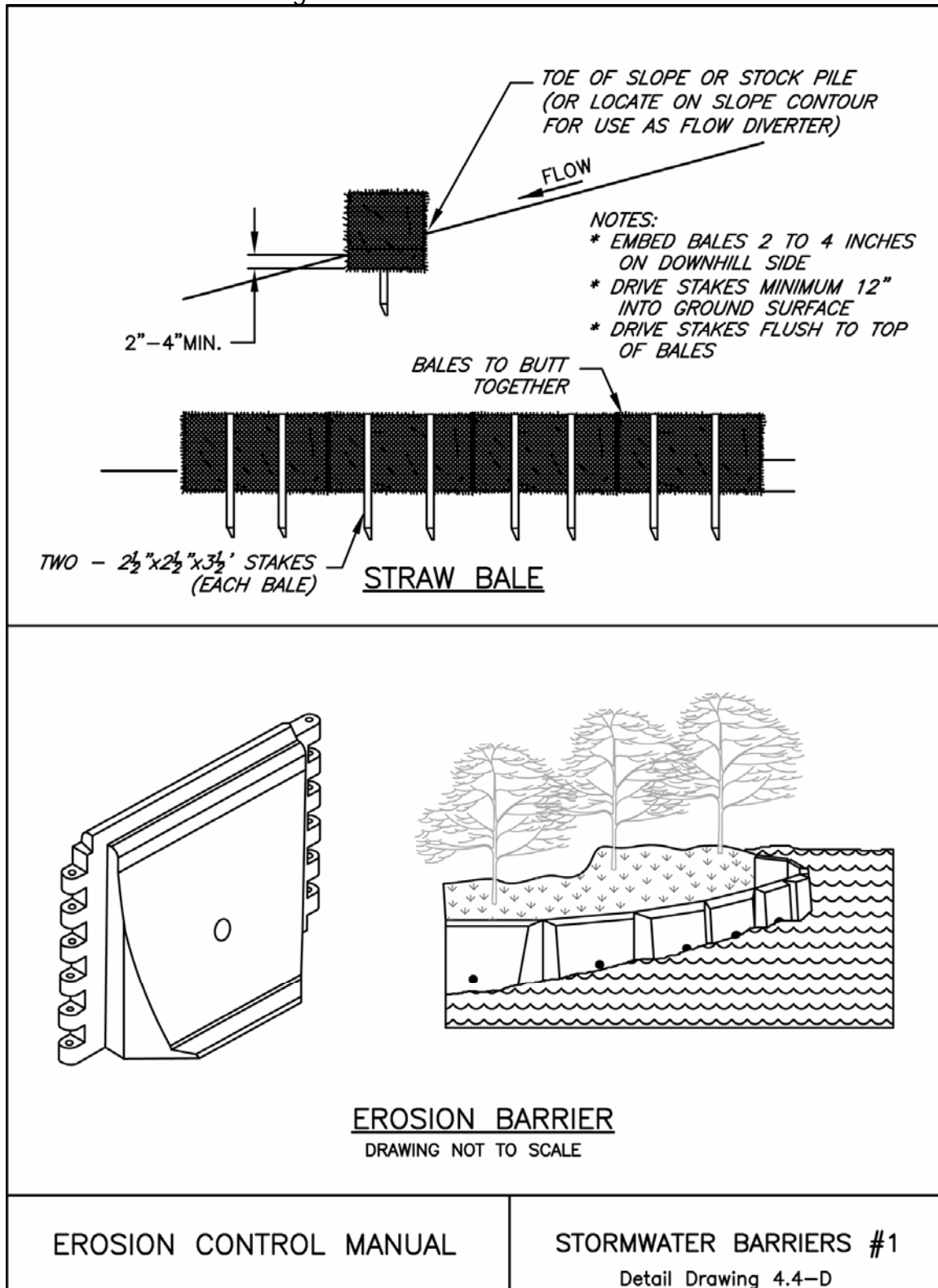
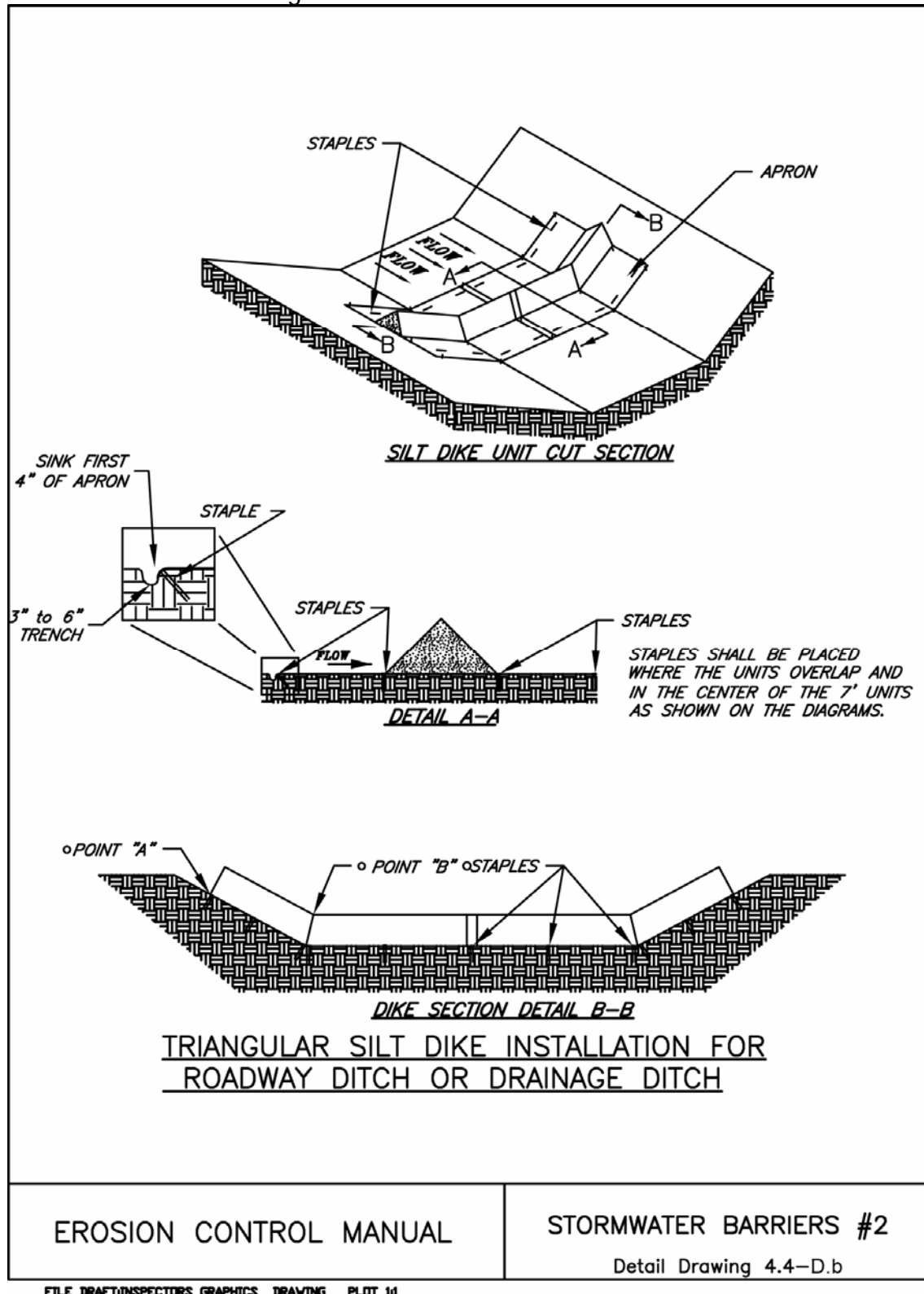


Figure 4.4-D.b Stormwater Barriers



4.4.5 Sediment Traps and Ponds

Purpose

To control sediment-laden flows leaving the site and to collect and store sediment eroded from exposed ground surfaces disturbed during site development. Designers are encouraged to consider whether ponds created to control sediment and other pollutants during site development can also be used to manage post-development stormwater runoff. In general, erosion control ponds are larger than post-development stormwater management facilities.

Conditions Where Practice Applies

- Downhill of areas with exposed soils.
- Sediment Traps: Each trap shall have a tributary drainage area limited to 3 acres or less and slopes of less than 50 percent.
- Sediment Ponds: Each pond shall have a tributary drainage area of 10 acres or less and slopes of less than 50 percent.
- Multiple traps or ponds may be needed to control sediments from leaving the site.
- Because of site and soil variability, traps and ponds shall be designed to meet specific site conditions. Given Portland's climate and clay soils, most sediment traps and ponds when used alone will not meet instream and 1200-C permit discharge limits. Facility size, configuration, and flow limits vary, based on particle size and settling ability of site soils. In general, these facilities shall be designed with adequate holding time to settle fine soils. Designers are encouraged to use multi-cell or flocculant-based systems.

Shall Not Be Used

- Alone without upslope clean stormwater diversion and erosion prevention BMPs.

Design Criteria/Specifications

- A licensed Oregon professional engineer shall design pond and trap systems.
- Temporary interceptor dikes or swales may be constructed to divert runoff to sediment traps or ponds.

Siting

The designer should consider sediment control needs during design, especially the need for sediment traps and ponds. In general, sediment traps and ponds shall:

- Be located offline from any natural site drainage.
- Be located at the end of a site drainage control structure.
- Be located on the lowest portion of the site.
- Have no groundwater flows that could limit facility effectiveness.
- Have stabilized inlet, outlet, and side slope structures capable of withstanding predicted flows before the facility receives flow.
- Have depth markers within the sediment basin to easily measure sediment deposits after water settling.
- Have a drainage system that dewateres the pond within 36 hours for maintenance.
- Have adequate access for maintenance procedures.
- Be demarcated or otherwise flagged or fenced for protection from construction vehicles.

The designer is also encouraged to consider using post-development stormwater management facilities for stormwater control and/or partial sediment control during the site's development phase. **Post-development stormwater management facilities are not sufficient to handle flows during the site construction phase.** They may be used for polishing of flows, but not for primary stormwater and sediment control.

Inlets and Outlets

- All inlet and outlet structures shall be adequately stabilized for predicted flows and stabilization will be in place before flows are received.
- The designer is encouraged to use armoring or erosion control blankets rated to withstand predicted flows.
- Outlet protection shall be provided to reduce erosion at the pipe outlet. A turbidity curtain, fabric-wrapped outlet, or similar filter shall be constructed to filter runoff before discharge from the construction site.
- Designers shall designate survey control points to locate the riser during high water events.

- The designer is encouraged to use a floating skimmer or perforated riser with a gravel jacket, or their equivalent, to further filter outlet discharge from the trap or pond.
- Pond and trap discharges shall be at least 1 foot below the spillway.
- Check Portland's Stormwater Management Manual for more guidance on inlet and outlet structures.

Sediment Traps

- See Figure 4.4-E for detail drawing.
- The sediment trap may be formed by excavation or by construction of a compacted embankment. It shall have a sediment storage depth not to exceed 1.5 feet, topped by a maximum 2-foot-deep settlement zone. Sediment trap side slopes shall be 3H:1V or flatter. The outlet of the trap shall be a weir/spillway, providing a minimum 1-foot overflow depth between the spillway and embankment.
- Calculate the required sediment storage volume using the USDA Natural Resources Conservation Service's Universal Soil Loss Equation or Revised Universal Soil Loss Program (as described in Appendix A of this manual), and assume a minimum 1-year sediment accumulation period for design purposes. For the purposes of this calculation, assume that 1 cubic foot of sediment weighs 130 pounds.
- Determine the bottom surface area of the sediment trap using the calculated sediment volume and the maximum 1.5 foot depth and 3:1 side slope requirements.
- Determine the total trap dimensions by adding an additional 2 feet of depth for settling volume (before overtopping of spillway) above the sediment storage volume, while not exceeding 3:1 side slopes.
- Consider using freeboard within the spillway design to trap additional sediment.
- A 3:1 ratio of trap length to width is desirable. Length is defined as the average distance from the inlet to the outlet of the trap. Residence time will depend on soils and shall be sufficient to allow for adequate settling. A good rule of thumb is 36 hours of residence time within the system.

Sediment Ponds

- See Figure 4.4-G for detail drawing.
- A sediment pond may be formed by partial excavation and/or by construction of a compacted embankment. It may have one or more inflow points carrying polluted runoff. Baffles shall be included throughout the pond to spread the flow, which will increase the pond's residence time.

- A securely anchored riser pipe is the recommended principal discharge mechanism, with an emergency overflow spillway. The riser pipe shall be netted or hooded to prevent entry of large debris into the pipe. The riser pipe shall also be perforated and covered with filter fabric and a gravel “cone” for filtration, or solid with a 1-inch-diameter dewatering hole and perforated drain pipe.
- The sediment pond shall have a sediment storage depth no greater than 3 feet, topped by a 2-foot-deep (minimum) to 4-foot-deep (maximum) settlement zone and an additional 1-foot minimum of freeboard.
- The pond side slopes shall be 3H:1V or flatter. Fencing of the facility may be required or desirable for safety around deep ponds without safety benches.
- Calculate the required sediment storage volume using the USDA Natural Resources Conservation Service’s Universal Soil Loss Equation or Revised Universal Soil Loss Program (as described in Appendix A of this manual) and assume a minimum 1-year sediment accumulation period for design purposes. For the purposes of this calculation, assume that 1 cubic foot of sediment weighs 130 pounds.
- The pond riser pipe and outlet pipe shall be sized to carry at least the 10-year design storm, or the designer shall use a design storm acceptable to the City.
- A 3:1 ratio between the pond length and width is desirable. Length is defined as the average distance from the inlet to the outlet of the trap. Use baffles in the pond to help prevent short-circuiting and to increase the effective pond length where site conditions prohibit constructing a pond with a direct 3:1 length-to-width ratio.

Maintenance Specifications

- All ponds and traps shall be maintained before major rainstorms to ensure they have capacity for flows. Designers shall consider drain valves, forebays, and other features that provide ease of maintenance.
- Designers shall consider the type of maintenance vehicle required and provide sufficient access. (Large equipment needs 15-foot-wide roads.)
- Sediments shall be removed when they fill one-third of the pond’s design capacity.

Removal Specifications

- Traps and ponds shall remain in place until an adequate portion of the site is stabilized or adequately protected by other erosion prevention and sediment control BMPs. If the applicant wishes to remove these facilities before complete site stabilization, the City shall determine when and under what conditions these traps and ponds may be removed.

Installation Tips

- Construct the trap or pond at the bottom of the drainage, sited on well-compacted and stabilized soils.
- Ensure that inlet and outlet structures are adequately designed for predicted flows.
- Do not route all stormwater through the trap or pond. Segregate and divert clean stormwater to an approved receiving system.
- Consider using post-development stormwater management facilities as polishing facilities after the sediment pond or trap.

Signs of Failure

Symptoms	Cause	Solution
Muddy water exits trap or pond.	<ul style="list-style-type: none"> • Upstream erosion prevention controls are insufficient. • Residence time is insufficient. • Outlet system does not adequately filter flows. 	<ul style="list-style-type: none"> • Provide additional erosion prevention BMPs. • Recalculate sizing design, and upsize facility if needed.
Trap or pond is overflowing.	<ul style="list-style-type: none"> • Outlet is plugged. • Clean flows are running into facility. • Facilities are inadequately sized. 	<ul style="list-style-type: none"> • Maintain system. • Divert any clean stormwater flows around worksite and facility to approved receiving system. • Review sizing criteria, and upsize facility if needed.

Figure 4.4-E Sediment Trap

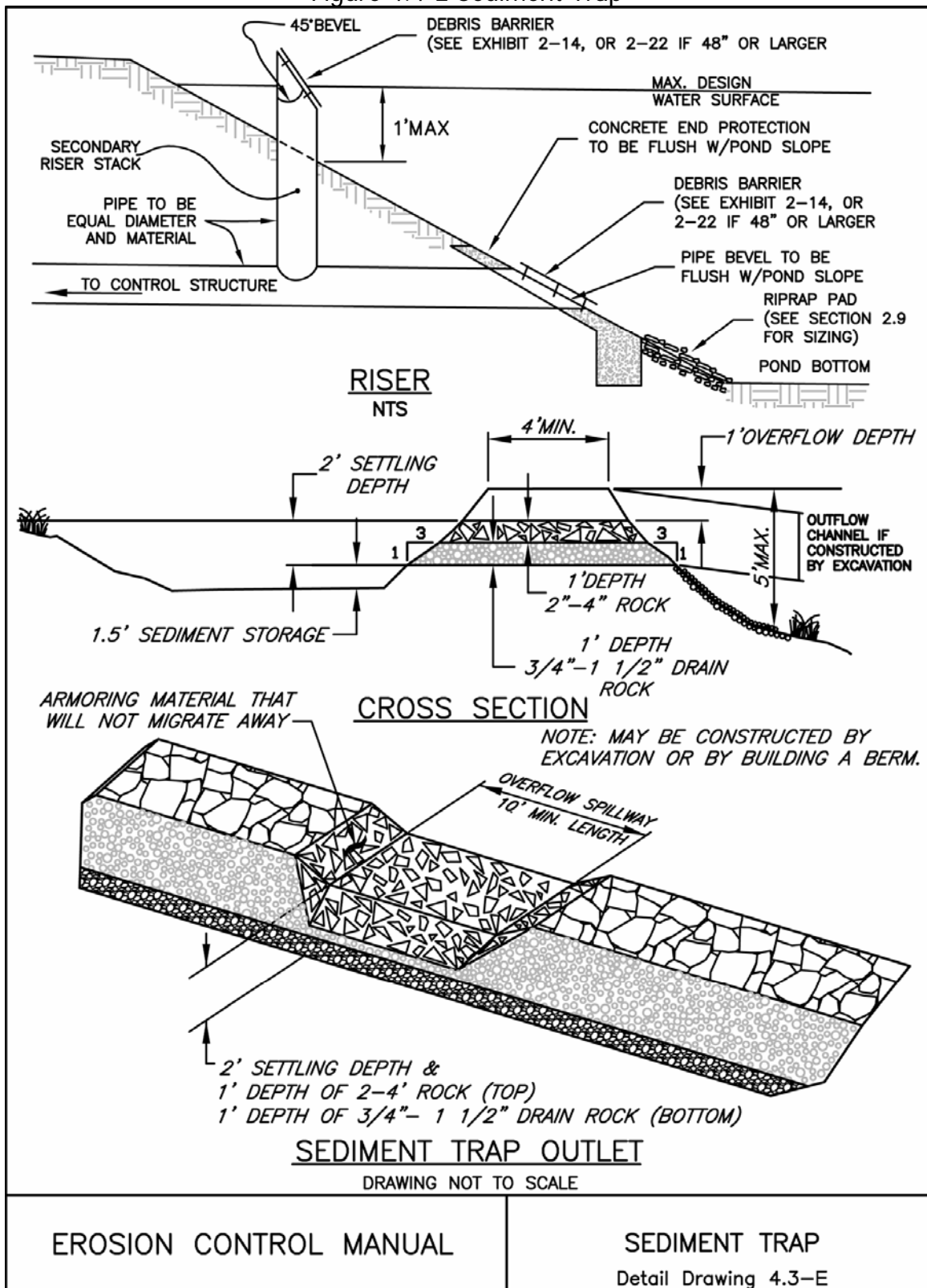
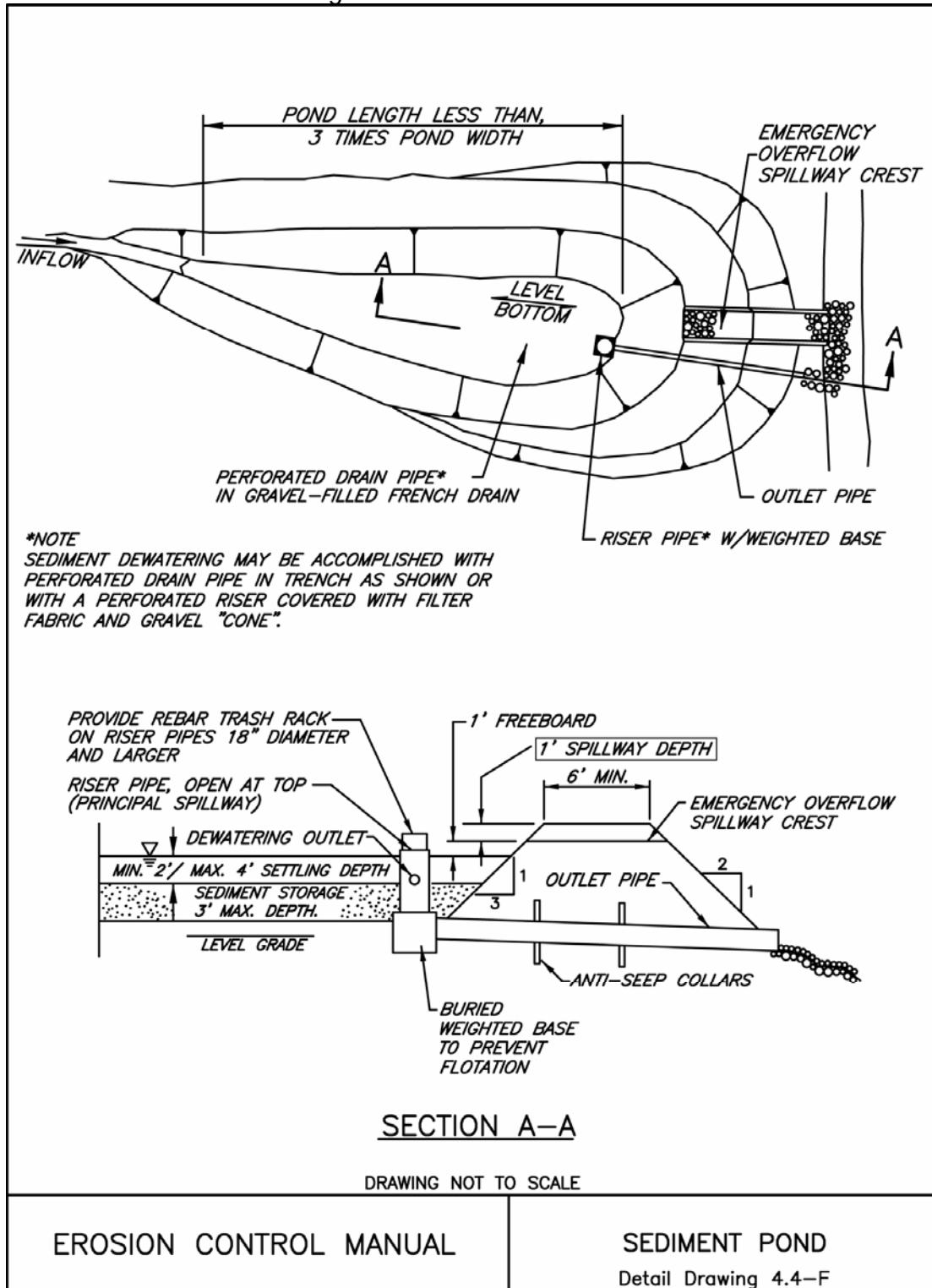


Figure 4.4-F Sediment Pond



4.5 EROSION PREVENTION BMPS

Erosion prevention BMPs can be the simplest and most effective measures that can be taken to retain sediments onsite. The following BMPs protect exposed soil surfaces from rain-generated splash erosion and can help slow flows across a site of ground disturbance. All sites shall incorporate at least one type of erosion prevention measure when exposed to a ground-disturbing activity.

4.5.1 Surface Roughening

Definition

Surface roughening includes a variety of methods to create ridges, furrows, or terraces in the soil surface. The ridges, furrows, or terraces run perpendicular to the slope and the natural direction of runoff, slowing the runoff.

Purpose

To help establish vegetative cover, prevent erosion, allow for infiltration, and trap sediment by reducing runoff velocity.

Conditions Where Practice Applies

- All slopes steeper than 4H:1V and greater than 5 vertical feet.
- Any bare soil needing at least some erosion prevention BMPs.

Shall Not Be Used

- On sites with slide or safety hazards, roughening shall be used at the discretion of the contractor or other site professional.

Design Criteria/Specifications

There are different methods for roughening the soil surface, and the selection of an appropriate method depends on the type of slope and the desired temporary or permanent slope vegetative treatment. The major consideration when using this BMP is to develop grooves or furrows that lie perpendicular to (across) the slope. Other factors to consider are slope steepness, mowing requirements, and whether cutting or filling forms the slope.

The following criteria are for disturbed areas where existing vegetation has been removed:

- All vegetation sites require some surface roughening: stair step, grooving, furrowing, or tracking.

- Areas that will be mowed (slopes less than 3:1) may have small furrows parallel to the slope contours (across the slope) left by discing, harrowing, raking, or other grooving methods from seed planting machinery operated on the contour.
- Areas with vegetation that will not be mowed may be stair-step graded, grooved, or left rough after filling.
- Slopes steeper than 2:1 shall be stair-stepped with benches (see Figure 4.5-A). Stair-step grading is also appropriate for soils containing large amounts of rock. Each step catches material that sloughs from above and provides a level site to convey or detain drainage or establish vegetation. Stairs shall be wide enough to work with standard earth-moving or maintenance equipment (12 feet minimum with no more than 15% slope). Heights shall be slope specific, but shall not exceed 3 feet without appropriate soils analysis or retaining structure support.
- Excessive compaction of soils shall be avoided during grubbing.
- Tracking can compact soils, reducing infiltration. Tracking with a bulldozer is the least preferred method of roughening, but is better than not roughening at all.
- Tracking shall be done up and down the slope to leave track tread indentations across the slope.
- Roughened soil surfaces shall be seeded and mulched as quickly as possible. If conditions are not appropriate for seeding, the area shall at a minimum be mulched or covered with an erosion control blanket.

Maintenance Specifications

- Roughened areas without other cover shall be inspected after every rainstorm. If grooves or stair-steps fill in, leaving less than one-third of the original groove or stair depth, the sediment shall be removed and the site re-roughened if necessary.

Removal Specifications

- Roughening is a permanent site feature.

Installation Tips

- Track up and down slopes so tread furrows are perpendicular to the slope (see Figure 4.5-B).
- Use proper equipment for installation of furrows.
- Cut furrows a minimum of 1 inch in depth.
- Avoid excessive compaction of soils.

- Control concentrated flows to the slope. Divert flows away from the top of the slope.
- Tracking with bulldozer treads is the minimal acceptable practice. Other roughening forms (e.g., disking, benching, and terracing) are more effective.
- Seed and groundcovers shall be in place as soon as possible and shall provide adequate cover before the beginning of the wet season.
- Companion BMPs include mulching, vegetative cover, tackifier, and plastic sheeting.

Signs of Failure

Symptoms	Cause	Solution
Bare soil in wet season.	<ul style="list-style-type: none"> • Lack of adequate cover. 	<ul style="list-style-type: none"> • Mulch or appropriately cover to prevent rainfall contact.
Rill erosion.	<ul style="list-style-type: none"> • Lack of penetration of furrows. • Migration of mulch. 	<ul style="list-style-type: none"> • Regrade and recover.
Slope failure.	<ul style="list-style-type: none"> • Concentration of runoff from top of slope. • Groundwater emergence. • Unstable soils. 	<ul style="list-style-type: none"> • Provide adequate collection and conveyance system – e.g., a pipe slope drain. • Install trench drain to intercept drainage and groundwater seepage (discharge to approved disposal point).

Figure 4.5-A Stair-Step Grading

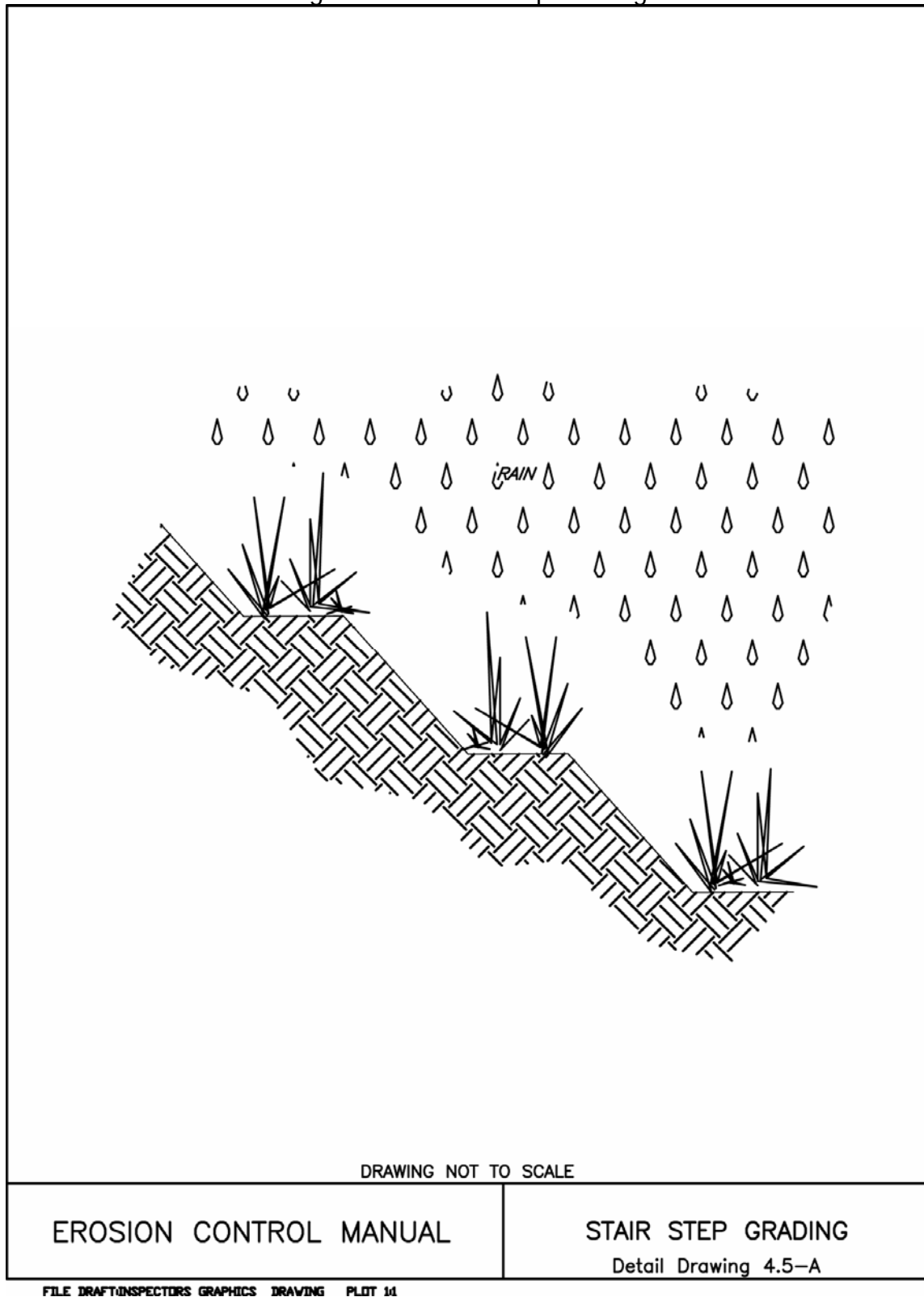
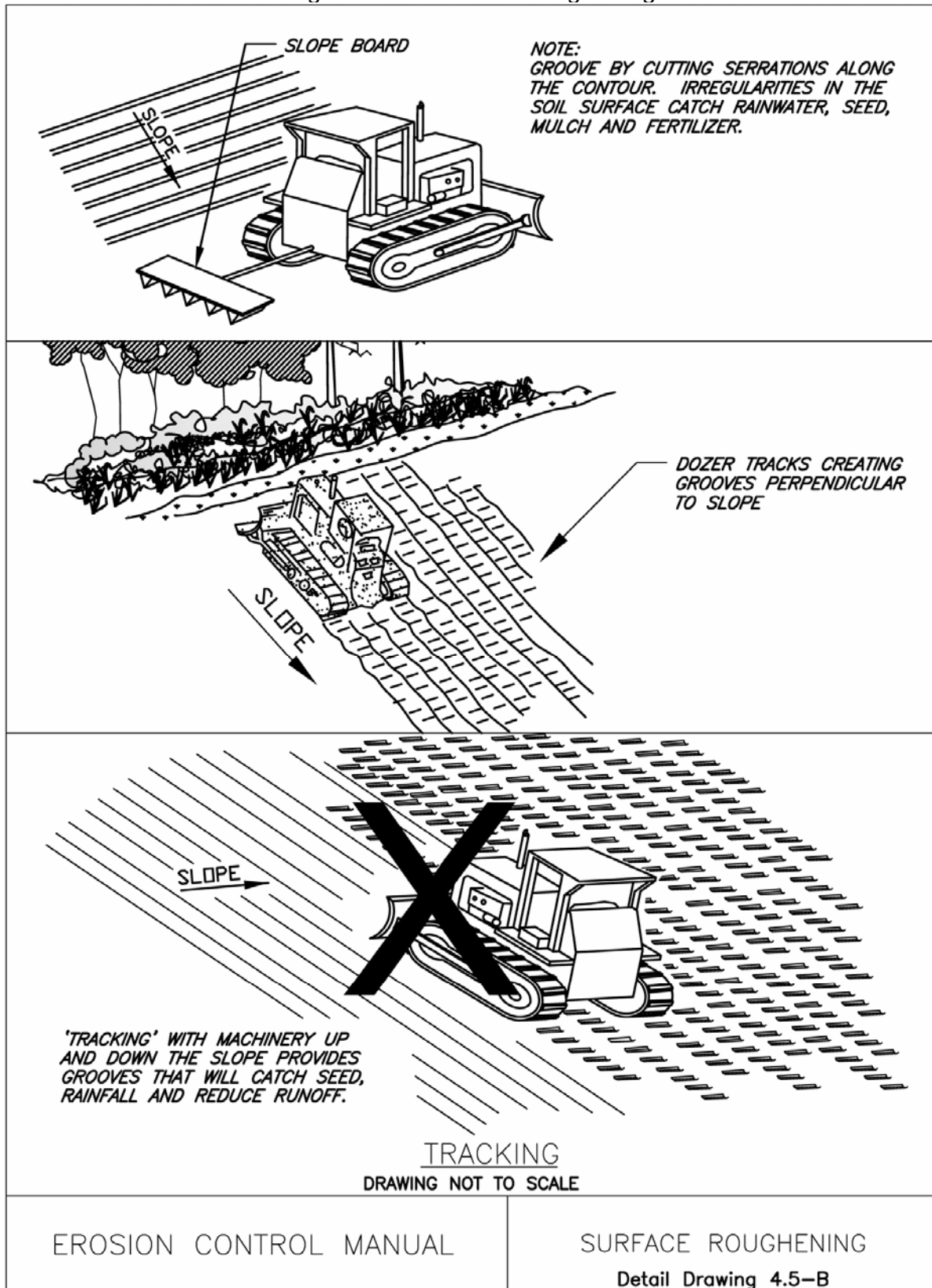


Figure 4.5-B Surface Roughening



FILE DRAFT\INSPECTORS GRAPHICS DRAWING PLOT 141

4.5.2 Temporary Grasses and Permanent Vegetative Cover

Definition

Grasses are planted to help control erosion during construction activities because they sprout and provide protection quickly. Temporary grasses are meant to be replaced at the end of the project with permanent vegetative cover.

Permanent vegetative cover consists of grasses or other plants that are intended to control erosion on the site as well as be part of the site's permanent landscaping. If appropriate species are selected, grasses used for temporary vegetation can also be part of the permanent vegetation for the site.

Purpose

To minimize erosion and sedimentation by stabilizing exposed soils with vegetation and mulching.

Conditions Where Practice Applies

- Ground surfaces likely to be exposed during the wet season (October 1 through April 30) or surfaces likely to be exposed for more than 3 weeks during the dry season.
- Areas that will not be subjected to heavy wear or are not working soils piles used by ongoing construction traffic.
- Exposed ground surfaces at the end of the construction period. (Permanent cover shall be established before removal of any erosion control BMPs.)
- Temporary or permanent stabilization of new or disturbed ditches, ponds, trenches, dikes, or swales.

Shall Not Be Used

- On active stockpiles.
- By itself (without matting) after October 1.

Design Criteria/Specifications

Temporary Erosion Control Grasses

Although perennial ryegrass and non-native clover species are often used for erosion control, these plants can invade and cause problems for the city's natural areas. Native grasses and other native plants are highly recommended for erosion control. Check the seed mixes listed in this chapter.

The following design and implementation principles apply to temporary establishment of grasses. Many, but not all, of these principles also apply to permanent vegetated cover.

Table 4.5-A identifies recommended temporary and permanent seeds and plants. Table 4.5-B lists nuisance grass species that should be avoided.

Preparation

- All vegetation sites require some surface roughening: stair-stepping, grooving, furrowing, or tracking.
- Temporary grass cover shall be fully established by October 1, or other cover BMPs (e.g., mulch, blankets) shall be implemented until adequate grass coverage is achieved. To establish an adequate grass stand by October 1, it is recommended that seeding and mulching occur by September 1.
- Soil Preparation: Topsoil shall be prepared according to landscape plans, if available, or recommendations of the grass seed supplier.
- The use of native grass mixes that can be incorporated into a permanent vegetative cover is recommended. These grasses provide cover as quickly as the temporary varieties, and the areas do not need to be replanted later.

Seed

- Seeding: Seed mixes shall be designed to achieve erosion control within a short germination period (14 days). In general, use of quick-growing, sterile grasses and grains in mixture with permanent vegetative cover is recommended to achieve quick cover of exposed soils.
- Seeding rates are based on a minimum acceptable Pure Live Seed rate (PLS) of 80%. When the PLS is below 80%, seeding rates shall be adjusted accordingly.
- When possible, seed supplies shall be selected from local sources that grow local genetic strains. These supplies will usually contain fewer weed species that could be noxious or invasive to the local environment.
- Seed may be applied by three different methods:
 - Broadcast: Seed is scattered on the soil surface by hand or machine. This method is used mostly for smaller areas.
 - Hydroseeded: A mixture of water, seed, and sometimes fertilizers or mulch is sprayed onto exposed soils. This method is best for sites over 5,000 square feet in size.
 - Drilled: Seed is tamped down by equipment to inject seeds into exposed soils. This method is best for sites larger than 2 acres.

Fertilization

- Fertilize for grass seed only as needed or as specified in the supplier's recommendations. Compost is a superior soil amendment.

- Development areas within 50 feet of water bodies and wetlands shall use a non-phosphorus fertilizer.
- Nitrogen fertilizer is not recommended for grasses.
- Composted or straw mulch shall be spread uniformly immediately following seeding.

Mulch

- Composted or straw mulch shall be applied at double the hydroseed application requirement (4,000 pounds/acre).
- Composted or straw mulch shall be anchored on steeper slopes (greater than 3:1) by working it in by hand or with equipment (rollers, cleat tracks, etc).
- Hydromulch shall be applied with grass seed at a rate of 2,000 pounds/acre or as specified by the supplier.
- On slopes steeper than 10% (10:1), hydroseed and mulch shall be applied with a bonding agent (tackifier). The application rate and methodology shall be in accordance with seed supplier recommendations.
- Netting and anchors shall be used as needed. For disturbed areas on slopes and in ditches/swales, erosion control blankets, biodegradable netting, or jute is desirable and may be used instead of bonding agents to provide a stable area for seeding. Netting shall be anchored in accordance with the manufacturer's recommendations.

Maintenance

- Watering: Seeding shall be supplied with adequate moisture to establish grass. Water shall be supplied as needed, especially in hot or dry weather or on adverse sites. Water application rates shall be controlled to provide adequate moisture without causing runoff.
- Reseeding: Areas that fail to establish grass cover adequate to prevent erosion shall be reseeded as soon as such areas are identified, and all appropriate BMPs shall be implemented to establish adequate cover.
- Weed Control: The type of weed control (mechanical, hand removal, biological, or chemical methods) shall be specified. Chemical use shall be a last resort. Chemicals shall never be used within stormwater management facilities. The selected weed control regime shall adequately protect the selected seed mix.

Maintenance Specifications

- All plantings require water and nutritional support during the first 3 years of establishment. Removal of invasive plant species is recommended. The property owner is responsible for ongoing maintenance of any plantings used for permanent cover.

Removal Specifications

- Plantings can be temporary or permanent. At the end of site development, approved permanent site landscaping or establishment of a healthy stand of grass (or alternative vegetation as approved) must occur before removal of site erosion prevention BMPs.
- If plant cover is temporary, till the grasses into the ground if they are in permanent landscape areas or choose sterile seeds that will not return after one growing season. Grasses may need to be removed completely under hardscape areas.

Signs of Failure

Symptoms	Cause	Solution
Dying grass.	<ul style="list-style-type: none"> • Lack of adequate water. • Lack of soil nutrients. • Lack of air pores in soil (soil too compacted). 	<ul style="list-style-type: none"> • Provide temporary irrigation. • Top-dress with compost to hold moisture and provide nutrients and heat for seeds.
Bare spots in vegetative cover.	<ul style="list-style-type: none"> • Lack of seed contact with ground. • Seeding rate too low. 	<ul style="list-style-type: none"> • Rake, drill, or walk in seed to ensure good ground contact. • Overseed bare areas and ensure adequate water and nutrients.

Table 4.5-A. Grasses and Other Groundcover Plants for Temporary or Permanent Vegetative Cover

1. Native grasses may have different maintenance requirements and susceptibilities to horticultural chemical use.
2. Seeding rates must be combined to achieve a minimum overall seeding rate of 100 lbs per acre.
3. "Add Diversity" indicates that these species can be mixed in with more common species to avoid a monoculture.
4. Moisture range is from wettest to driest:
inundated-----wet-----saturated-----moist (mesic)-----dry or d`roughty (xeric)
wetland conditions

Scientific Name	Common name	Optimal Sowing Season	Germination Time	Common (C) or to Add Diversity (D)?	Bioswale or Dry Pond Sow Rate (Hand, lbs/acre)	Erosion Control Sow Rate (lbs/acre)	Moisture	Exposure	Seed size (S, M, L)	Commercial Accessibility of Local Eco-type
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Taller Grasses

Wetter Areas

Agrostis exarata	Spike bentgrass	early fall/spring	1-4 weeks	D	5	30	saturated to wet	sun	M	easy to medium, Portland Metro
Hordeum brachyantherum	Meadow barley	early fall/spring	1-2 weeks	C	25	40	wet to moist	sun	L	easy to medium, Willamette Valley

Scientific Name	Common name	Optimal Sowing Season	Germination Time	Common (C) or to Add Diversity (D)?	Bioswale or Dry Pond Sow Rate (Hand, lbs/acre)	Erosion Control Sow Rate (lbs/acre)	Moisture	Exposure	Seed size (S, M, L)	Commercial Accessibility of Local Eco-type
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Drier Areas

Bromus sitchensis	Sitka brome	early fall/spring	1-2 weeks	C	25	40	wet to moist	sun/ shade	L	easy, Willamette Valley
Bromus carinatus	California brome	Early fall/spring	1-2 weeks	C	25	40	dry to moist	sun	L	easy, Portland Metro
Elymus glaucus	Blue wildrye	early fall/spring	1-2 weeks	C	25	40	dry to moist	sun to shade	L	easy, Portland Metro
Elymus trachycaulus	Slender wheatgrass	early fall/spring	1-2 weeks	C	25	40	dry to moist	sun	L	medium to difficult, Willamette Valley

Scientific Name	Common name	Optimal Sowing Season	Germination Time	Common (C) or to Add Diversity (D)?	Bioswale or Dry Pond Sow Rate (Hand, lbs/acre)	Erosion Control Sow Rate (lbs/acre)	Moisture	Exposure	Seed size (S, M, L)	Commercial Accessibility of Local Eco-type
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Shorter Grasses

Wetter Areas

Deschampsia elongata	Slender hairgrass	early fall/spring	1-3 weeks	C	20	30	wet to dry	sun	S	easy, Portland Metro
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Recommended Non-Native Cover Crop Species

Festuca rubra var. commutata	Chewings fescue	year round	1-3 weeks	C	20	30-40	dry to moist	sun/ shade	S	medium to difficult, Portland Metro
Triticum spp.	Wheat	year round	1-3 weeks	C	50	60	dry to moist	sun	L	easy, Willamette Valley
Avena spp.	Oats	year round	1-3 weeks	C	50	60	dry to moist		L	easy, Willamette Valley
Regreen	Sterile wheat hybrid	year round	1-3 weeks	C	40	50	dry to moist	sun	L	medium to difficult, Portland Metro

Recommended Quick Establishment or Temporary Cover Crop Species

Deschampsia elongata	Slender hairgrass	early fall/spring	1-3 weeks	C	20	30	wet to dry	sun	S	easy, Portland Metro
Festuca rubra var. commutata	Chewings fescue	year round	1-3 weeks	C	20	30-40	dry to moist	sun/ shade	S	medium to difficult, Portland Metro
Hordeum brachyantherum	Meadow barley	early fall/spring	1-2 weeks	C	25	40	wet to moist	Sun	L	easy to medium, Willamette Valley
Bromus sitchensis	Sitka brome	early fall/spring	1-2 weeks	C	25	40	wet to moist	sun/ shade	L	easy, Willamette Valley

Scientific Name	Common name	Optimal Sowing Season	Germination Time	Common (C) or to Add Diversity (D)?	Bioswale or Dry Pond Sow Rate (Hand, lbs/acre)	Erosion Control Sow Rate (lbs/acre)	Moisture	Exposure	Seed size (S, M, L)	Commercial Accessibility of Local Eco-type
Bromus carinatus	California brome	early fall/spring	1-2 weeks	C	25	40	dry to moist	Sun	L	easy, Portland Metro
Elymus glaucus	Blue wildrye	early fall/spring	1-2 weeks	C	25	40	dry to moist	sun to shade	L	easy, Portland Metro
Elymus trachycaulus	Slender wheatgrass	early fall/spring	1-2 weeks	C	25	40	dry to moist	Sun	L	medium to difficult, Willamette Valley

Scientific Name	Common name	Optimal Sowing Season	Germination Time	Common (C) or to Add Diversity (D)?	Bioswale or Dry Pond Sow Rate (Hand, lbs/acre)	Erosion Control Sow Rate (lbs/acre)	Moisture	Exposure	Seed size (S, M, L)	Commercial Accessibility of Local Eco-type
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Forbs

<i>Gilia capitata</i>	Blue gilia	fall/spring		D	2	1 (w/ grass)	dry to moist	sun	M	medium, Willamette Valley
<i>Lotus purshianus</i>	Spanish clover	fall		D	2	1 (w/ grass)	dry to moist	sun	M	medium, Willamette Valley
<i>Lupinus albicaulis</i>	Sickle keel lupine	fall		D	1	1 (w/ grass)	dry to moist	sun	L	medium, Willamette Valley
<i>Lupinus rivularis</i>	Stream lupine	fall		D	1	1 (w/ grass)	dry to moist	sun	L	medium, Willamette Valley

Table 4.5-B. Nuisance Grass Species Not Recommended for Use on Erosion Control or Stormwater Projects or Not Allowed for Use in E-Zones

<i>Species</i>	<i>Common Name</i>	<i>State-Listed Noxious Weed?</i>	<i>Portland Nuisance or Prohibited Plant?</i>
<i>Agropyron repens</i>	Quackgrass	Yes (B-list)	Nuisance
<i>Agrostis alba</i>	Redtop Bentgrass	No	No
<i>Agrostis tenuis</i>	Colonial Bentgrass	No	No
<i>Alopecurus pratensis</i>	Meadow foxtail	No	Nuisance
<i>Anthoxanthum odoratum</i>	Sweet vernal grass	No	Nuisance
<i>Arrhenatherum elatius</i>	Tall oatgrass	No	Nuisance
<i>Brachypodium sylvaticum</i>	False brome	Yes (B-list)	Nuisance
<i>Bromus diandrus</i>	Ripgut	No	Nuisance
<i>Bromus hordaceus</i>	Smooth brome	No	Nuisance
<i>Bromus inermis</i>	Smooth brome	No	Nuisance
<i>Bromus japonicus</i>	Japanese brome	No	Nuisance
<i>Bromus sterilis</i>	Poverty grass	No	Nuisance
<i>Bromus tectorum</i>	Cheatgrass	No	Nuisance
<i>Festuca arundinacea</i>	Tall fescue	No	Nuisance
<i>Holcus lanatus</i>	Velvet grass	No	Nuisance
<i>Lolium multiflorum</i>	Annual ryegrass	No	Nuisance
<i>Phalaria arundinacea</i>	Reed canary grass	No	Nuisance
<i>Phalaris aquatica</i>	Harding grass	No	Nuisance
<i>Phleum pratensis</i>	Timothy	No	Nuisance
<i>Phragmites australis</i>	Common reed	No	Nuisance
<i>Vulpia myoros</i>	Rat-tailed fescue	No	Nuisance

EROSION CONTROL SEED MIXES AND SOURCES

The City of Portland highly recommends the use of native seed mixes and plants for erosion control, both temporary and permanent measures. Although perennial ryegrass and non-native clovers are often used for erosion control, these plants are invasive and can create problems off of your site. The city discourages their use.

The following list is for the Portland Metro Area, and does not include all Portland sources of suitable erosion control seed mixes. These sources carried native seed mixes when this manual was being updated.

Bosky Dell Natives, Inc.

2020 SW 8th Ave #323
West Linn, OR 97068
Contact: Laurie Hoffman
Phone: 503-638-5945
Fax: 503-638-8047

Emerald Seed & Supply

9330 NE Halsey St.
Portland, OR 97220
Contact: Arman Kluehe
Phone: 503-254-8414 / 800-826-8873
Fax: 503-254-8456
Website: emeraldseedandsupply.com
email: emeraldssc@uswest.net

Granite Seed

1697 West 2100 North
Lehi, UT 84043
Contact: Don Bermant
Phone: 801-768-4422
Fax: 801-768-3967
Website: www.graniteseed.com
email: granite@graniteseed.com

Hobbs & Hopkins, Ltd.

1712 SE Ankeny
Portland, OR 97214
800-345-3295
Fax 503-230-0391
www.protimelawnseed.com

Pacific Northwest Natives

1525 Laurel Heights Drives NW
Albany, OR 97321
Phone: 541-928-8239
Fax: 541-924-8855
email: cwe@proaxis.com

For more complete listings of nurseries and other sources of native seeds and plant materials, visit the following websites: www.nativeseednetwork.org or www.tardigrade.org/natives/nurseries.html

4.5.3 Mulch

Definition

Mulch is the name given to various organic or inorganic natural or synthetic materials that are spread or blown on the soil surface to prevent movement of soil by wind and rain. Mulches protect exposed soil surfaces from the force of falling rain, slow downslope flows, increase heat and moisture content for seeding and other vegetation, discourage weed growth, and, when adequately anchored, can provide slope stabilization. Mulches can be loose materials (compost), rock, or organic fibers in a water-based matrix that dry as mats on the soil surface (hydraulic mulch, bonded fiber matrix).

Purpose

Mulch minimizes erosion by providing a protective cover over disturbed, bare, or reseeded soils and will help ensure the success of seeding or revegetation. Minimal thickness protects soils from splash erosion, while thicker layers are effective for additional sediment control.

Conditions Where Practice Applies

- As a cover on ground surfaces and stockpiles exposed during the wet season (October 1 through April 30).
- As a mulch to enhance vegetation establishment in areas that have been seeded.

Shall Not Be Used

- Mulch other than gravel shall not be used on slopes greater than 3:1 without erosion blankets or netting on top of the mulch or without a tackifier.
- No organic mulches shall be used on streams or water quality/quantity facility banks below the high water line.
- Straw shall not be used by itself as a permanent erosion control practice.

Design Criteria/Specifications

- All materials shall be loose and free of significant sediment loads. Straw shall be certified weed-free. See Table 4.5-C for recommended straw species.
- Consider use of mulches such as compost that provide additional plant support nutritional value or soil structure value.
- Mulches shall be spread uniformly throughout the entire area and may be integrated into the top layer of soil if appropriate.

Table 4.5-C. Straw Recommended for Use in Establishing Vegetation from Seeds

Scientific Name	Common name	Bioswale or Dry Pond Sow Rate (Hand, lbs/acre)	Moisture	Commercial Accessibility of Local Eco-type
<i>Recommended Straw</i>				
Triticum spp.	Wheat	1.5 ton/acre	mesic	easy, Willamette Valley
Bromus carinatus	California brome	1.5 ton/acre	xeric to mesic	medium, Portland Metro
Bromus sitchensis	Sitka brome	1.5 ton/acre	wet to mesic	medium, Portland Metro
Bromus vulgaris	Columbia brome	1.5 ton/acre	xeric to mesic	medium, Portland Metro
Elymus glaucus	Blue wildrye	1.5 ton/acre	xeric to mesic	medium, Portland Metro
Hordeum brachyantherum	Meadow barley	1.5 ton/acre	wet to mesic	easy to medium, Willamette Valley

THIS TABLE APPLIES ONLY TO STRAW USED TO ESTABLISH VEGETATION. IT IS NOT FOR EROSION CONTROL. FOR EROSION CONTROL, SEE TABLE 4-5D.

- Mulches are most effective when anchored, especially organic mulches. Anchoring can include punching materials into the soil, mixing mulches with tackifier products, or combining mulches with erosion blankets or netting. Mulch may otherwise migrate offsite.
- Mulches shall be applied at the rates specified in Table 4.5-D.
- Mulch made from nuisance or prohibited plant species or weeds shall not be used.
- Because straw is readily flammable when dry and also can blow away, it shall be used only in wet weather or areas where the soil is moist or wet.

Maintenance Specifications

- Additional mulch applications shall be made when the current mulch layer has migrated or is no longer a uniform depth.
- Additional mulch shall be added to suppress weed growth.

Removal Specifications

- Mulches may be left in place permanently, either as part of the final landscaping plan or integrated into the topsoil as a soil amendment.

Table 4.5-D. Mulch Application Rates and Notes

Mulch Material / Quality Standards	Minimum Application Rate per 1,000 sq. ft.	Minimum Application Rate per Acre	Depth of Application	Considerations
Compost Well composted Free of coarse foreign matter (plastics, metals, etc.) Size dependent on use	6-9 cubic yards	265-400 cu. yd.	2 inches for splash control 4-6 inches for sedimentation	<ul style="list-style-type: none"> Coarser grades for more erosion-prone areas. Finer grades may be windblown. All grades good for landscaping and as a soil amendment. Durability dependent on grade and type of compost.
Wood Chips Green or air-dried Free of coarse material	3-9 cu. yd.	130-400 cu. yd.	1-3 inches for splash control 4-6 inches for sedimentation	<ul style="list-style-type: none"> Durable, but subject to movement on >6% slopes. Add 12 lbs. organic compost or nitrogen fertilizer per ton chips. Not for use in fine turf areas. Apply with mulch blower, chip handler, or by hand.
Bark Chips/Shredded Bark Green or air-dried Free of coarse material	3-6 cu. yd.	130-400 cu. yd.	1-3 inches for splash control 4-6 inches for sedimentation	<ul style="list-style-type: none"> Durable, but subject to movement on >6% slopes. Add 12 lbs. organic compost or nitrogen fertilizer per ton chips. Not for use in fine turf areas. Apply with mulch blower, chip handler, or by hand.
Wood or Cellulose Fiber Dyed visible color Should contain no growth-inhibiting factors	35-50 pounds	1,500-2,000 pounds	N/A	<ul style="list-style-type: none"> Apply with hydroseeder with or without seed. Second application in different direction to avoid shadowing. Double application rate, in two layers, on critical areas. Use tackifier as recommended by manufacturer. Do not use in hot/dry weather.
Crushed Rock 1½ inch fractured face Clean, with less than 10% fines	12 tons	410 tons	1-2 inches	<ul style="list-style-type: none"> Use as landscape rock in permanent landscape areas.
Straw (or Hay) Air dried Free from seeds and coarse material	90-100 pounds (2-3 bales)	2-2½ tons (80-130 bales)	2 inches for splash control 4-6 inches for sedimentation	<ul style="list-style-type: none"> May be windblown or moved by flows - needs to be anchored.

Installation Tips

- Grade and roughen the soil surface (see Figure 4.5-B) before applying mulches.
- If placing mulch on slopes steeper than 3:1, install erosion blankets or netting in accordance with the manufacturer's instructions for trenching, overlapping, and fastening (see Erosion Control Blankets, section 4.5.4).
- Use mulch in conjunction with a perimeter sediment control barrier.
- Disc, punch, or use another approved anchoring method to bind mulches to the soil.
- Ensure a minimum of 2 inches uniformly across the entire site. Increase the thickness of the mulch layer to a minimum of 4 to 6 inches on steeper slopes.

Signs of Failure

Symptoms	Cause	Solution
Soil migration offsite.	<ul style="list-style-type: none">• Mulch has gone bare or is no longer at least 2 inches uniform thickness.	<ul style="list-style-type: none">• Clean up migrated soil.• Add more mulch.• Disc or punch in. Repair rills or gullies.• Re-cover with alternative material – e.g., blanket, tackifier, plastic sheeting, or other approved BMP.

4.5.4 Erosion Control Blankets

Definition

Erosion control blankets are mats composed of organic fibers or inorganic materials held by synthetic or biodegradable netting. Most blankets are rolled products, but some may be sprayed onto exposed soils. Jute netting is not by itself an erosion control blanket.

Purpose

To provide immediate protection and physical stabilization of disturbed soils. Erosion control blankets are typically used when vegetative cover cannot be achieved because of soils or time of year or where slopes are too steep for mulch or other erosion prevention BMPs. They can be used to enhance the success of seeding, planting, and/or sod application. The blankets are usually left in place as a permanent BMP.

Conditions Where Practice Applies

- As channel stabilization against concentrated runoff flows (with adequate approval and permits for active waterways).
- On areas of steep slopes and areas that are prone to erosion.
- As a cover on ground surfaces exposed during the wet season (October 1 through April 30).
- As a supplemental aid to seed and/or mulch treatment on slopes or in ditches or swales.
- Erosion control blankets shall be installed only in accordance with the manufacturer's specifications and limits on use.

Shall Not Be Used

- On slopes steeper than the manufacturer's recommendation.
- On rough surfaces (unless using spray-on mats) where there is not good contact with the ground.

Design Criteria/Specifications

- See Figures 4.5-C and 4.5-D for detail drawings.
- Where soil is highly erodible, netting shall be used only in conjunction with organic mulch such as straw or wood fiber. The blanket shall be applied so it is in complete contact with the soil; if it is not, erosion will occur beneath it. Erosion blankets shall be securely trenched in

at the top of the slope and anchored to the slope in accordance with the manufacturer's recommendations (usually 1 anchor per 12 inches).

- Consider installing fiber rolls or other barriers on top of blankets at various locations on the slope to reduce the length of slope that receives high-speed flows. Use of rolls at the toe of the slope on streambanks will help secure the blanket and protect it from active wave/current action.
- Deformed plastic filament matting may be used for stream velocity protection and other special applications when approved by the applicable jurisdiction (city, state, federal government).
- Provide additional seed over and under mat installations to enhance vegetative cover growth.
- Blankets shall be loose enough to allow good contact with the ground.

Maintenance Specifications

- Blankets shall be inspected daily for signs of deformation or areas of sloughing under the blanket surface.
- If plant growth is not establishing as desired, consider spreading additional seed on top of the blanket.

Removal Specifications

Blankets are often left in place as permanent features. If they are temporary:

- Stakes or staples shall be biodegradable or shall be removed after the ground is stabilized with permanent cover.
- During removal, blankets shall be rolled from the bottom of the slope or the downstream end of a channel to the top to trap sediment from the toe of slope within the blanket roll.
- Consider reusing any blankets removed from channels as cover for banks or other sloped areas.

Installation Tips

- Allow adequate material for overlaps and trenching.
- Organic and/or thicker materials will provide enhanced protection of soils.
- Extra staples or anchoring may be required on steep slopes in accordance with the manufacturers' recommendations.

- Use wood or other biodegradable stakes in environmental zones and other sensitive areas.
- Groundcover and other plants may be planted through the blanket to provide permanent erosion protection.
- Consider using bioengineered systems in areas that need permanent vegetative cover or are in environmentally sensitive areas.
- If inspection is required, obtain inspection before covering the blanket with mulch or installing plantings through the blanket.

Signs of Failure

Symptoms	Cause	Solution
Blanket moved or deformed.	<ul style="list-style-type: none"> • Improperly or inadequately staked. • Joints not properly overlapped or secure. • Concentrated flows are directed into joint or weakly stapled areas. 	After adequately repairing erosional damage under blanket: <ul style="list-style-type: none"> • Adjust and re-anchor blanket. • Control or reduce upstream flows.
Slope creep/undermining.	<ul style="list-style-type: none"> • Blanket not making good contact with soils. • Flows directed under blanket edge. • Groundwater or slope failure issue. 	After adequately repairing erosional damage under blanket: <ul style="list-style-type: none"> • Add additional stakes to have blanket conform to contours of soils. • Ensure edges are anchored under incoming flows (in trench, under outfall, etc.). • Have qualified design professional check slope stability.
Erosion occurred.	<ul style="list-style-type: none"> • Flows too high for type of blanket used. • Blanket not secured. 	After adequately repairing erosional damage under blanket: <ul style="list-style-type: none"> • Choose blanket rated to withstand site flows. • Re-anchor blanket.

Figure 4.5-C Erosion Blankets – Slope Installation

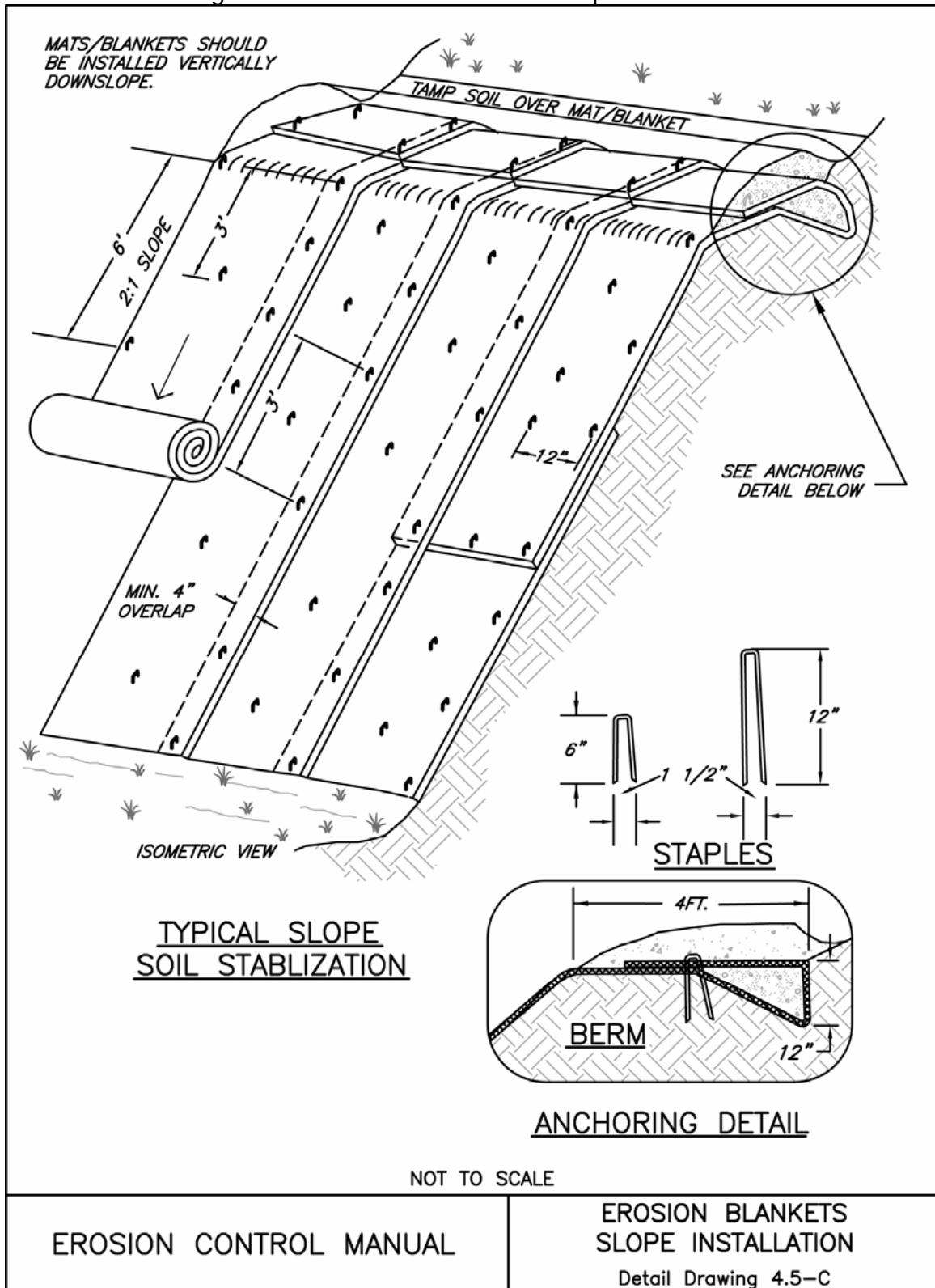
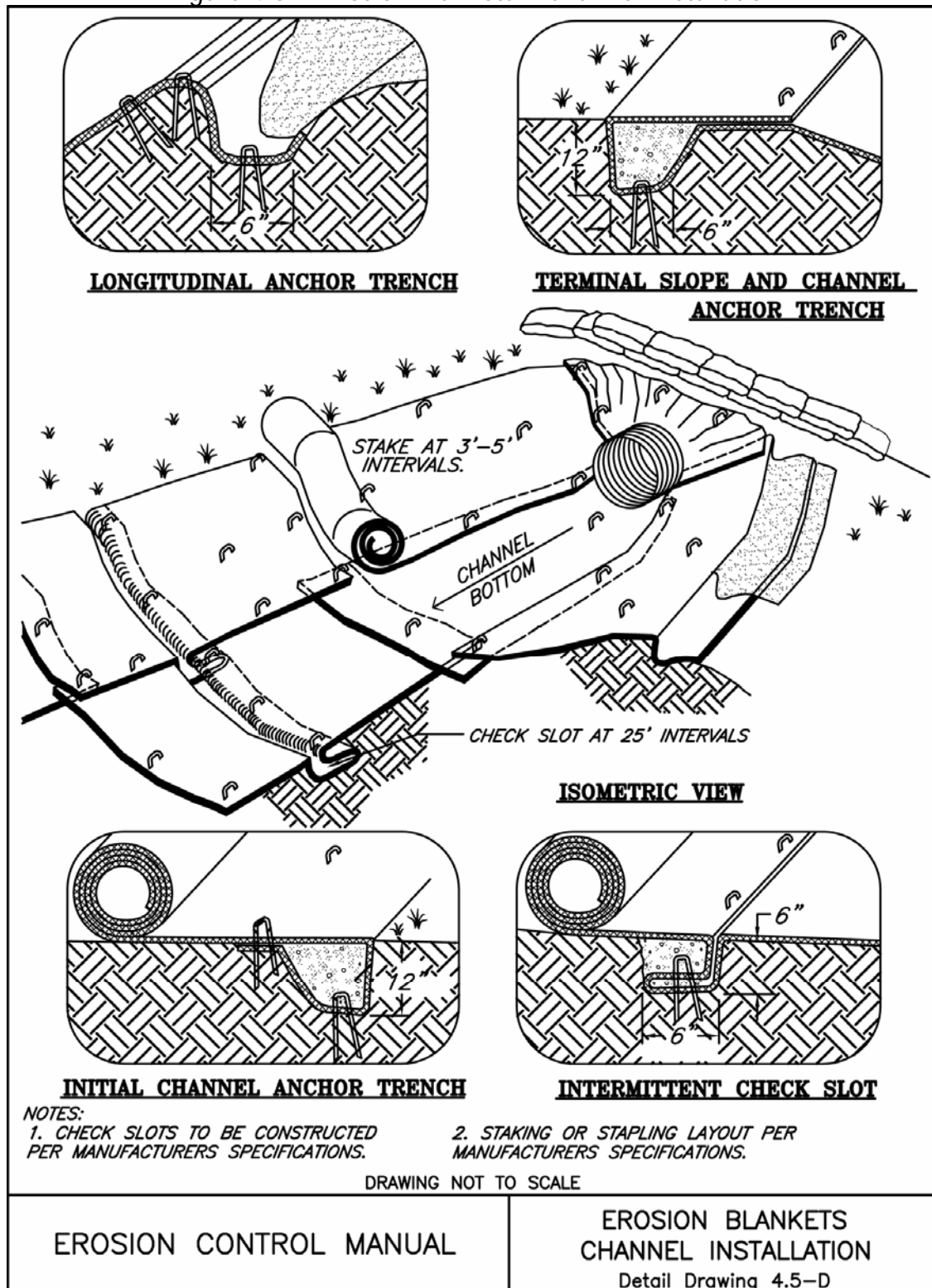


Figure 4.5-D Erosion Blankets – Channel Installation



4.5.5 Plastic Sheet Covering

Definition

Plastic sheets can be spread temporarily on the ground surface or on stockpiles to prevent water infiltration and erosion by wind or water.

Purpose

To provide immediate erosion protection, usually for small areas, where vegetative cover cannot be achieved because of soil conditions, steep slopes, or time of year. Plastic sheets can provide temporary erosion protection on soils, spoils, and other erodible stockpiles. Plastic sheets can also be used to direct runoff water to an approved disposal point.

Note: Sheeting shall always be used with appropriate trenching and conveyance of runoff to an approved disposal point.

Conditions Where Practice Applies

- On disturbed areas that require immediate erosion protection.
- On steep slopes (greater than 2H:1V) and areas of moderate slopes that are prone to erosion.
- On disturbed ground surfaces and stockpiles exposed during the wet weather season (October 1 through April 30).

Shall Not Be Used

- Plastic sheeting is not the preferred choice for erosion prevention cover, except for protection of a stockpile that must be kept dry for reuse.
- Erosion control blankets, mulch, or seeding are preferred for soil stabilization and erosion control.

Design Criteria/Specifications

Note: Plastic sheeting will sterilize underlying soils in warm weather. Consider using another method (seed/mulch or blankets) if preservation of topsoil biota is desirable.

- See Figure 4.5-E for detail drawings.
- Plastic sheeting shall be polyethylene (any color is acceptable) and have a minimum thickness of 6 mil.

- Sheeting shall be installed either overlapping side to side or top to bottom. Sheeting shall be maintained tightly in place by using staples, stakes, sandbags, 12-inch-diameter rock, cinder blocks, or other rough surface materials with substantial weight.
- Sheeting shall be applied as a continuous sheet whenever possible. All seams shall be taped, appropriately welded, or weighted down for the full length of the seam, and there shall be at least a 12-inch overlap of all seams. For seams parallel to the slope contour, the uphill sheet shall overlap the downhill sheet. For seams crossing up and down slope, the sheeting shall be laid so the top sheet faces away from any prevailing wind. No runoff shall run under the plastic covering.
- Collection trenches shall be placed at the top and around the base of any slope or stockpile or other area using sheeting. The top trench shall direct water away from the sheeting to an appropriate collection and conveyance system (e.g., pipe slope drains or swales). The trench may be designed and used to assist in conveyance as well as anchoring. The bottom trench shall be sized and stabilized to adequately route and control flows from the sheeting surface.

Drainage from plastic sheeting shall be controlled to prevent discharge of runoff directly onto uncontrolled, undisturbed areas of the development site.

Maintenance Specifications

- Plastic sheeting shall be visually inspected for tears or weak points daily and after every storm.
- Areas receiving runoff from plastic sheeting shall be checked daily for erosion.

Removal Specifications

- Plastic sheeting shall be removed at the end of the project.

Installation Tips

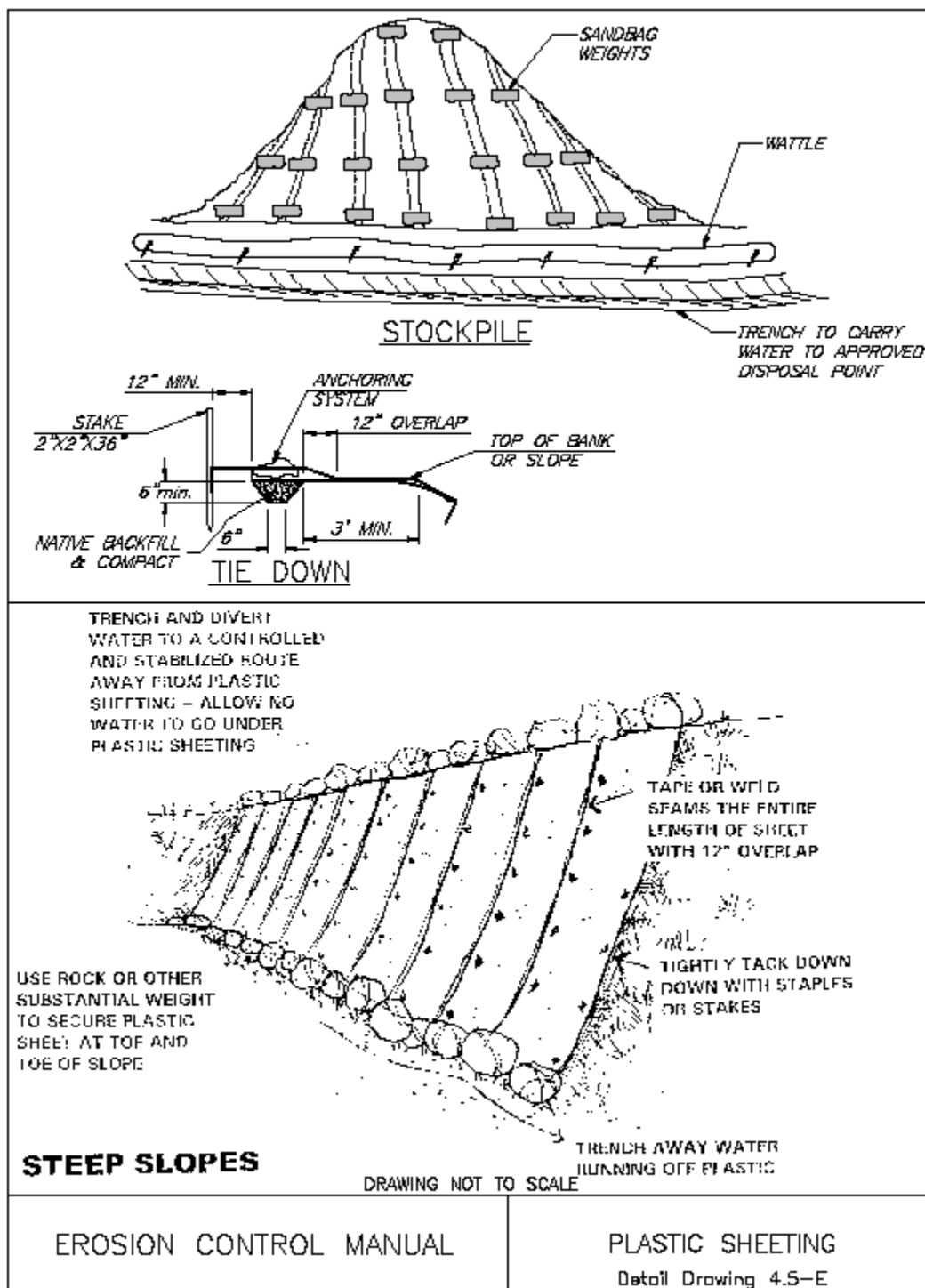
- Apply in a continuous sheet covering the slope or pile.
- Secure edges tightly. Check seams and material condition often. Inspect weights frequently to ensure the plastic stays in place.
- Maintain and adequately size drainage trenches to carry flows generated by the plastic.
- Topsoils under plastic may become anaerobic, killing various organisms that make soil healthy. Because it is uncertain how long it takes for anaerobic conditions to develop, consider using grass cover instead to hold topsoils and improve topsoil health.

Note: Mulching, vegetative cover, tackifier, and blankets are preferred BMPs.

Signs of Failure

Symptoms	Cause	Solution
Seams split/fabric torn.	<ul style="list-style-type: none">• Too much weight strain.• Inadequate overlap or weld.• Wind shear	<ul style="list-style-type: none">• Adjust plastic layers and anchoring, choosing more and lighter anchoring materials.• Weld seams appropriately.• Cover with duct tape or additional plastic.
Fabric blown off/bare soils.	<ul style="list-style-type: none">• Wind shear.	<ul style="list-style-type: none">• Replace plastic and add extra anchoring.

Figure 4.5-E Plastic Sheetting



FILE DRAFTNSPECTORS GRAPHICS DRAWING PLOT 14

4.5.6 Dust Control

Definition

Dust control includes a variety of methods and materials intended to prevent erosion of dry soils.

Purpose

To minimize wind erosion of bare soils.

Conditions Where Practice Applies

- On bare soils exposed to wind, especially unpaved roads, stockpiles, and soil tracked onto paved roads or other impervious surfaces.

Design Criteria/Specifications

Dust is formed when bare soils come into contact with the wind. The following BMPs are listed in an order that emphasizes prevention, then moves to stricter controls.

- **Administrative Control Methods:** These methods concentrate on preventative controls such as enacting traffic restrictions/speed limits, reducing work activities when wind speeds increase, enclosing bulk soil, and enclosing soil movement operations.
- **Structural and Mechanical Control Methods:** These methods concentrate on actions taken to reduce exposure during site work operations. Options include:
 - Tilling soil into big clumps with fewer fines that are easily moved by air.
 - Stabilizing storage, vehicle movement, and parking areas by installing gravel surfaces over geotextile fabric.
 - Installing or maintaining vegetative or structural barriers, including preserving perimeter trees (especially on the windward side of the site).
 - Sweeping paved surfaces to remove tracked soil.
 - Applying mulches to exposed soils.
 - Using plastic sheeting for dust control on stockpiles.
- **Water:** Water is the wetting agent of choice to use on soils to resist wind erosion. Ensure that spray types and flow volumes and rate do not cause soil washoff.
- **Chemical Control Methods:** When other methods fail, the site may require application of dust control/wetting agents. Options include tackifier mixtures to bind soil or application of other binding agents (following the manufacturer's directions). Ensure that the chemical agent is allowed for the intended use (e.g., for roadways or streambanks) and applied per the manufacturer's specifications.

Maintenance Specifications

- Ensure that no fugitive dust leaves the site.
- Follow the manufacturer's recommendation for reapplication rates, drying times, and total load allowances.
- Ensure that any liquids applied do not cause rill erosion on bare soils.

Installation Tips

- Choose planning-level procedures first. Use signage, tailgate meetings, or other methods to ensure that employees understand procedures.
- Spray liquids during breaks and at the end of the workday to allow maximum contact time before the site is subjected to equipment.

Signs of Failure

Symptoms	Cause	Solution
Dust generated.	<ul style="list-style-type: none">• Insufficient binding agent used.• Equipment traffic not following procedures.• High winds.	<ul style="list-style-type: none">• Reapply binding agent per manufacturer's recommendation.• Lower site vehicular speeds.• Install buffers or barriers (permanent or temporary) near roadways.

4.5.7 Armoring

Definition

Armoring BMPs are varieties of erosion protection BMPs that will withstand high site flows (e.g., outfall discharge points, landslide areas). At times, only structures or hardscape materials will be sufficiently sturdy, but other measures should be used when possible, such as bioengineering, sod installation, or use of erosion control blankets that are rated to withstand flows. Many of these armoring systems can be installed with a large vegetative component that will provide additional environmental and erosion control benefits. Armoring BMPs are usually permanent measures.

Examples include:

- Reinforced soil retaining systems
- Articulated mats
- Plates
- Gabions
- Cellular confinement systems
- Turf reinforcement mats
- Riprap

Reinforced soil retaining systems are a mixture of permanent BMPs, including hinge block, grid containment, and articulated armoring systems. These products are usually preformed structural systems that are laid atop soils and then backfilled with a variety of materials – usually concrete, rock, soil, sand, or planted with vegetation. While these systems can be more expensive than other treatments, ease of installation and permanency can make them desirable.

Purpose

Armoring provides erosion protection and stabilization for slopes, discharge points such as outfalls, and, rarely, streambanks. They are best used under high flow or unstable soil conditions. NOTE: Soil Bioengineering is preferred. See Section 4.5.8.

Conditions Where Practice Applies

- High-flow channel stabilization or outfall protection.

Note: Soil bioengineering techniques are preferred in environmental and buffer zone areas and for low-flow waterway conditions.

Use of these systems in drainageways and other waterways may be prohibited. Bioengineering techniques are the preferred alternative in bank and waterway projects because of their ability to provide upland habitat for animals and instream habitat for salmonids. In sensitive areas, it may be preferable to retain larger setbacks from the stream to avoid the need to armor banks and allow for natural channel migration. Use of these systems within a waterway or drainage area will likely require a variety of permits from state and federal natural resource protection agencies (Oregon Department of Fish and Wildlife, Oregon Department of State Lands, US Army Corps of Engineers, National Marine Fisheries Service, etc.).

Design Criteria/Specifications

- See Figures 4.5-F and G for detail drawing.
- All materials shall be installed per the manufacturer's guidance and shall be designed by a licensed professional when required by the permitting authority. A licensed professional shall be consulted where there are high flow, steep slope, or poor soil conditions.
- Follow the general installation principles below unless the manufacturer's instructions specify a different installation method:
 - Excavate the application area to a depth that ensures that systems have adequate foundations and are keyed in well. Most reinforced soil retaining systems need to be set so they are flush with, or slightly lower than, adjacent terrain. The exposed surface shall be leveled and free of minor obstructions such as stones and debris. Major obstructions can be left in place, with materials established around them. Soils shall be compacted or removed as necessary.
 - Lay panels or sheets on the exposed surface. Use appropriate pins, hinges, staples, hog rings, or overlapping suggested by the manufacturer. Trench in the top, bottom, or sides of the panel or sheets as specified by the manufacturer.
 - Anchor reinforced soil-retaining systems per the manufacturer's instructions. Anchoring shall occur at least along slope crests, upstream system edges, steep areas, and areas likely to experience the highest turbulence from nearby surface water systems.
 - Fill systems with material of choice, as rated for the selected system. Consider using some element of vegetative cover to enhance aesthetics and provide habitat.

Maintenance Specifications

- All systems shall be maintained as installed for the life of the BMP. System repair typically consists of additional anchoring or top-dressing with fill materials on an as-needed basis.

Removal Specifications

Reinforced soil retaining systems are almost always used as permanent site features. Some systems may be used for temporary roadways. If the system is temporary:

- After removal, loosen underlying soils to allow for infiltration and then seed and mulch if the area is to remain pervious.

Installation Tips

- Make sure there is a good foundation with adequately compacted soils.
- Adequately anchor, especially on slope crests, upstream edges, and other areas with steep slopes or high velocity flows.
- Consider overseeding or otherwise planting systems to enhance appearance and performance.

Signs of Failure

Symptoms	Cause	Solution
System is broken or otherwise compromised.	<ul style="list-style-type: none"> • Flow is too intense. • Materials are weak. 	<ul style="list-style-type: none"> • Revisit flow calculations. • Add additional material supports or fill support materials. • Overseed or overplant with vegetation to help hold in fill material.
System has slid or been displaced.	<ul style="list-style-type: none"> • Foundation was insufficiently compacted, and the slope slipped. • System was not adequately anchored. 	<ul style="list-style-type: none"> • Reestablish slope; compact and reinstall system. • Replace and add additional anchors to system.
Erosion has occurred.	<ul style="list-style-type: none"> • Flows are too high for type of system used. • Flows are undermining the system. • Fill materials are missing. 	<p>After adequately repairing erosional damage under or within system:</p> <ul style="list-style-type: none"> • Choose system rated to withstand site flows. • Replace and/or re-anchor system. • Add additional fill as necessary. • Overseed or otherwise vegetate system to hold fill material.

Figure 4.5-F Armoring

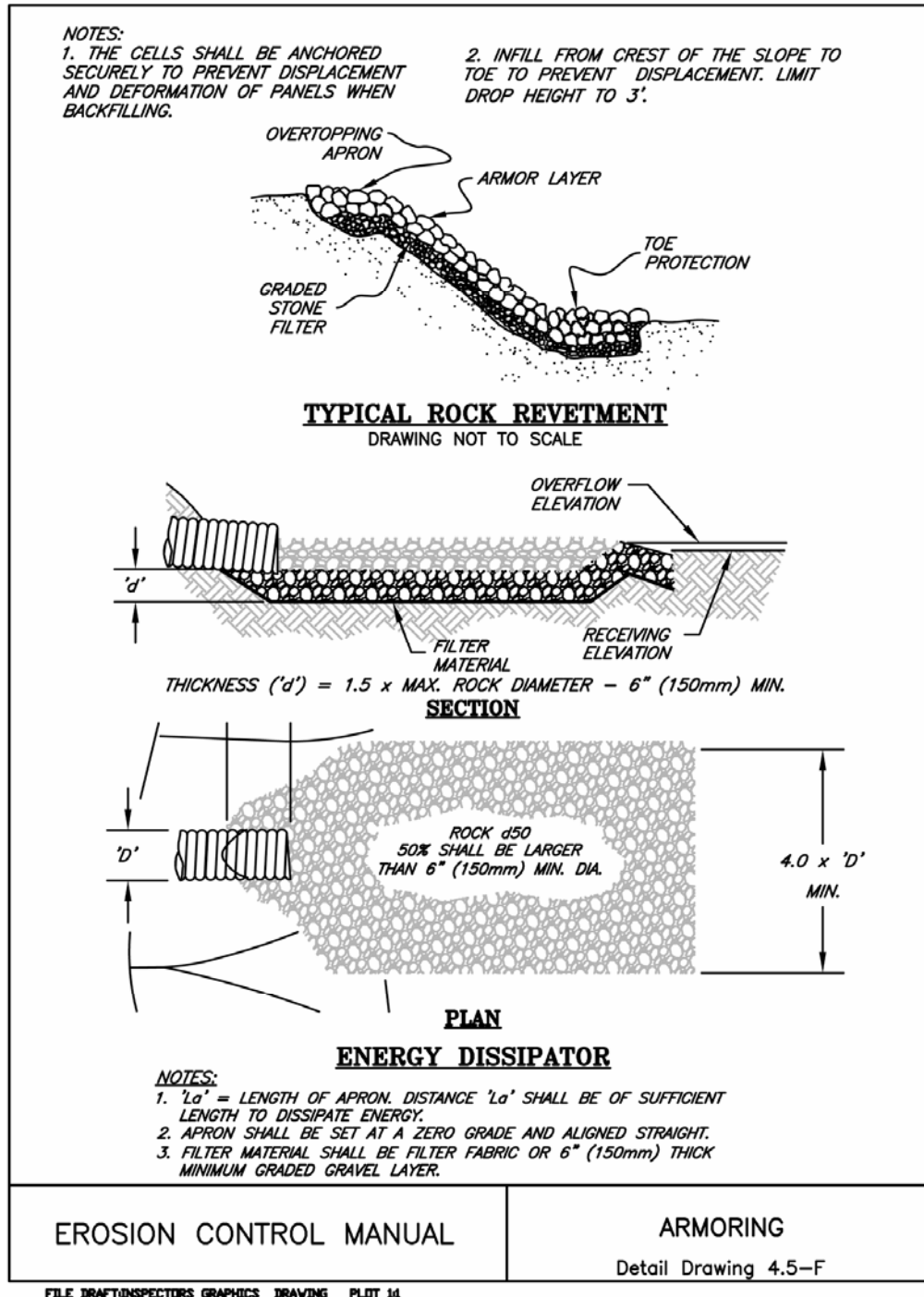
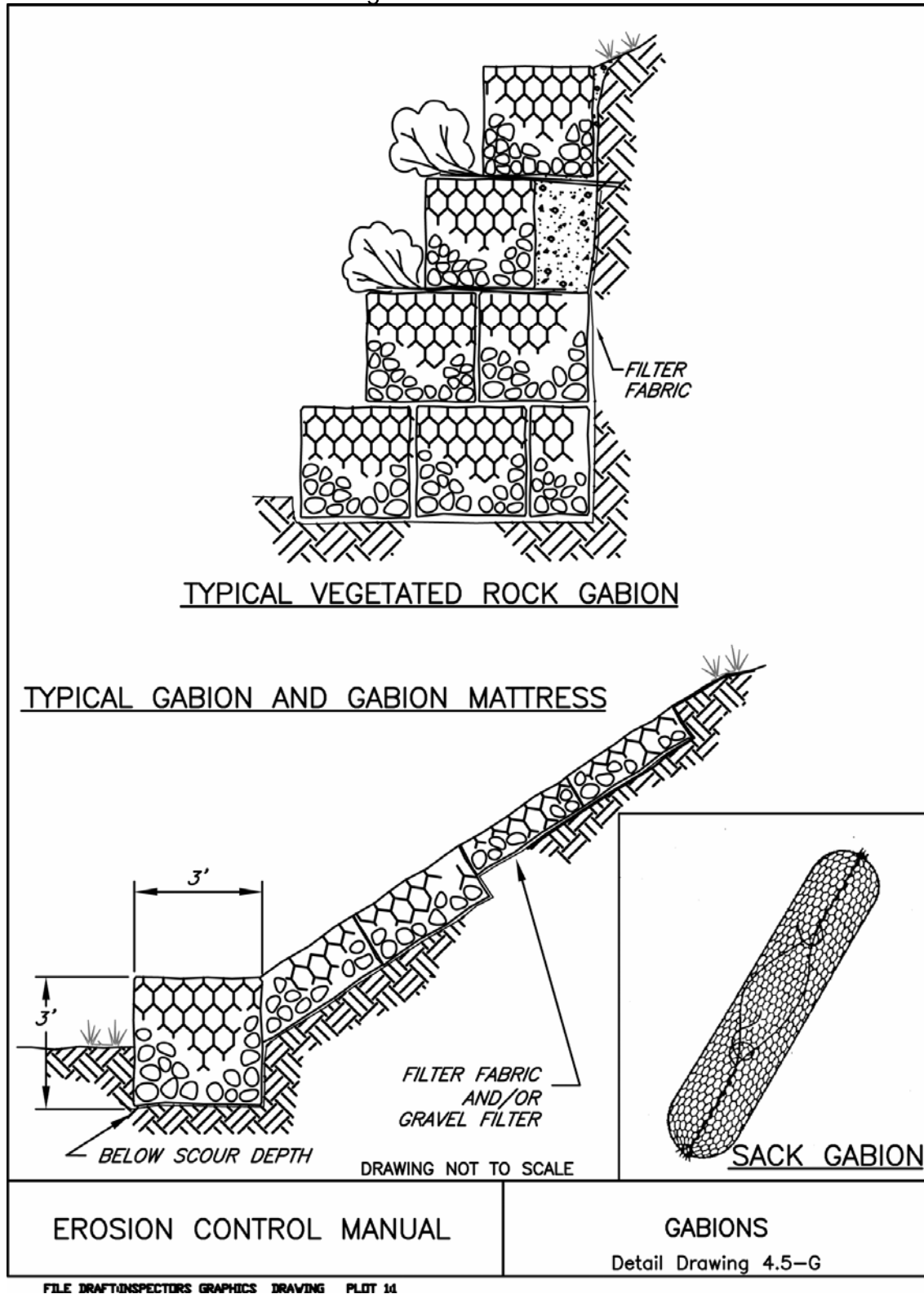


Figure 4.5-G Gabions



4.5.8 Soil Bioengineering

Soil bioengineering BMPs are the ideal measures to use on streambanks and upland slope areas. Bioengineering uses vegetative materials to provide structural support to banks and reduce flow across banks. Soil bioengineering BMPs provide permanent vegetative cover. Live stakes and live fascines are discussed below.

Vegetated slope reinforcement involves more comprehensive measures, such as brush mattresses and brush packing. These measures must be designed by a licensed professional engineer and cannot be constructed without a building permit. They are not included in this manual.

Live Stakes

Definition

Live stakes are stakes of woody plant materials that are capable of rooting with relative ease (e.g., willow). These cuttings are cut to length, tamped into the ground, and then grow into mature shrubs.

Purpose

Live stakes are an effective, inexpensive system for securing natural geotextiles such as jute netting, coir, or other blanket surface treatment. They grow into mature shrubs that, over time, will serve to stabilize the soils and restore the riparian zone habitats. Live stakes offer no immediate erosion control.

Conditions Where Practice Applies

- Streambank restoration or construction projects.
- Simple, shallow slope stabilization projects.
- Slopes where permanent vegetation, but no mowing, is desired.

Shall Not Be Used

- By themselves for immediate erosion control protection or soil reinforcement.

Design Criteria/Specifications

- See Figure 4.5-H for detail drawing.
- Grade slopes to appropriate slope – preferably 2H:1V or flatter, especially when soils are less cohesive or lenses of sand and gravel exist.
- Ensure that soils are moist before planting, and water plants after installation.

- Use fresh, healthy, straight, and live wood that is at least 1 year old, with side branches removed and bark intact. The stakes must be taken from species that root easily from cuttings, such as willow or other native species approved by the permitting authority (city, state, or federal government).
- Prepare cuttings ½ inch to 2 inches in diameter and 2 to 3 feet in length. Cut the basal (butt) ends cleanly at an angle to facilitate easy insertion into the soil. Cut the top square or blunt for tamping.
- Keep cuttings fresh and moist after they have been prepared in appropriate lengths. Soak cuttings for 24 hours before installation.
- Tamp the cuttings into the ground at right angles to the slope and angled downstream. Tamp cuttings into the ground carefully for approximately four-fifths of their length. Two to five bud scars should remain above the ground surface. Remove any additional length above ground. Place stakes in a random configuration from 2 to 5 feet apart to prevent gullies from forming and to produce a more natural effect in the revegetation area.

Maintenance Specifications

- All plantings need water and nutritional support during the first 3 years of establishment. Removal of invasive plant species is also required. Ensure that there is a responsible party for this ongoing plant maintenance.

Removal Specifications

- These systems are permanent measures.

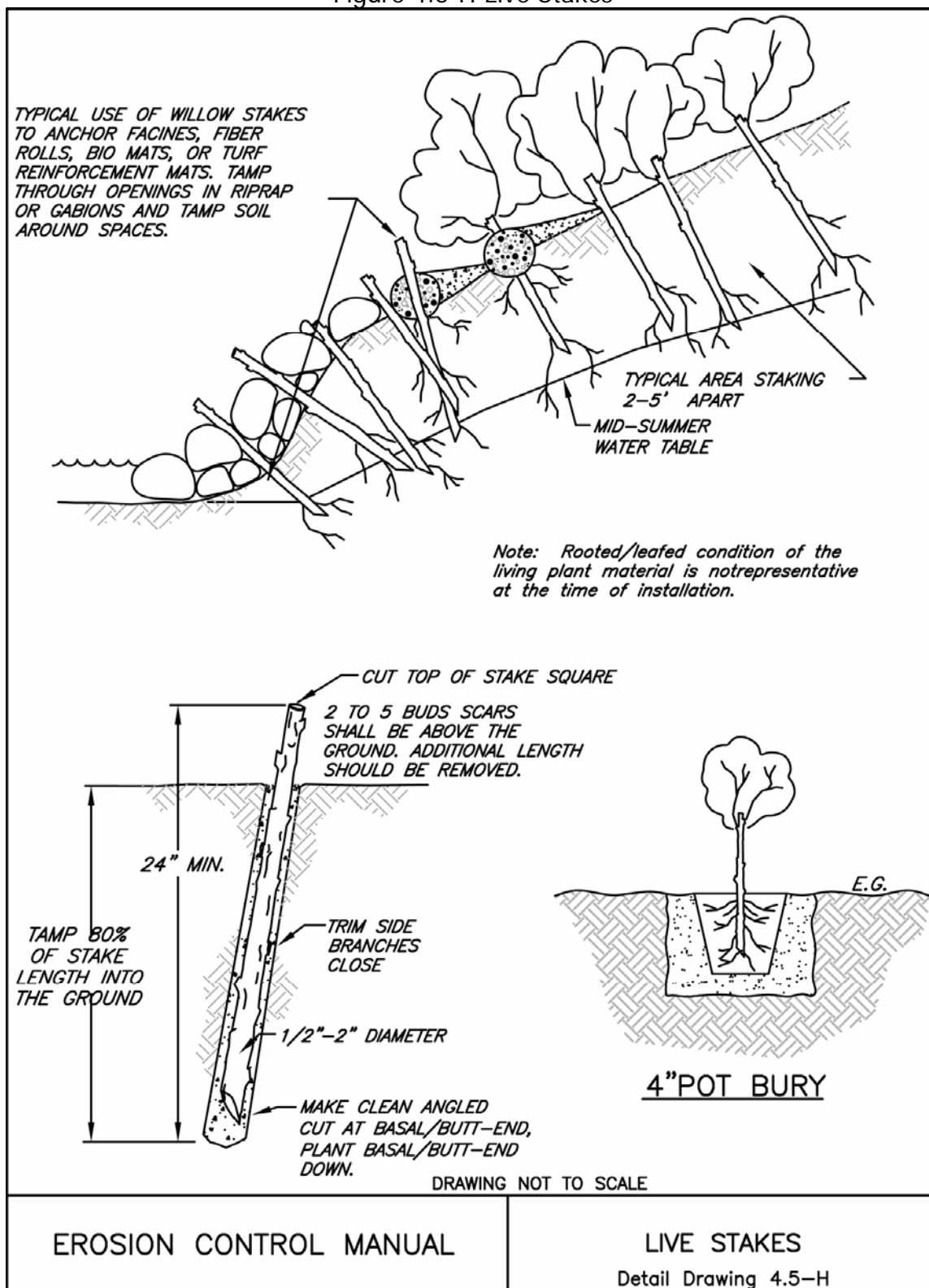
Installation Tips

- Use a saw for cuts rather than an ax; there is less chance for bark damage.
- Do not split stake ends during installation.
- Use a pilot bar or other tool to pre-drill holes in firm soils. When the tool is removed, be careful not to enlarge the hole, reducing the ability of the live stake to remain in place and be effective.
- Determine whether temporary irrigation will be needed to establish growth. If using irrigation, infiltrate water at least 2 inches deep.
- Ensure that the soil is moist and is adequately worked in around the live stake.

Signs of Failure

Symptoms	Cause	Solution
Live stake has dislodged or is gone.	<ul style="list-style-type: none">Stake was not installed to correct depth.Soil was not adequately packed around live stake (tamping it in).	<ul style="list-style-type: none">Replace missing stakes with adequate soil tamping.Verify that the stream or runoff flow problem has been corrected.
Stakes are not growing.	<ul style="list-style-type: none">Lack of contact with soil.Live stake is dead because of lack of water or nutrients and/or anaerobic soil conditions.	<ul style="list-style-type: none">Rebury or replace stakes, adding water and nutrients if needed.
Soil is running off bank or slope.	<ul style="list-style-type: none">Live stakes were used by themselves for erosion control.	<ul style="list-style-type: none">Protect soils with blankets, mulches, or other covers (including seed).

Figure 4.5-H Live Stakes



Live Fascines

Definition

Live fascine structures are bundles of live cut branches of wetland or streamside materials, usually willow or dogwood species. These bundles are placed into trenches along the streambank and grow out perpendicular to the bank, providing protective vegetative cover and a root structure to stabilize banks.

Purpose

Fascines provide surface stability and prevent erosion by holding soil on the face of the streambank. They also support the establishment of the surrounding aquatic, riparian, or upland slope vegetation.

Dead fascines may be used in some circumstances. Even non-living materials can slow surface water flows and allow for more infiltration on sites with limited water supply. Note that such installations will not grow shrub canopy cover.

Conditions Where Practice Applies

- Streambanks that require immediate erosion protection and streambank revegetation projects.
- Slopes where permanent vegetation, but no mowing, is desired.

Shall Not Be Used

- On 1:1 or steeper slopes.

Design Criteria/Specifications

- See Figures 4.5-I and 4.5-J for detail drawings.
- Prepare the slope by grading back to a 3H:1V or flatter slope, especially in less cohesive soils or soils with distinct material lenses.
- Ensure that the soils are moist and that plants are watered after installation.
- Assemble live fascines using fresh plant cuttings, with alternating basal (butt) ends. Live fascine bundles are 6 to 8 inches in diameter and tied securely with twine or rope every 12 to 15 inches.
- Install live fascines shallowly to follow the contour of banks, with a face length of 15 feet or less to prevent ground disturbance. Install live fascines in shallow trenches that are a shovel

deep and a shovel wide. Install from the bottom of the slope and work up to the top of the slope. See Table 4.5-E for recommended spacing.

Table 4.5-E. Recommended Spacing for Live Fascines
(measured along the bank face)

Slope Steepness	Undisturbed Erosive Soils	Undisturbed Cohesive Soils	Fill Soils
3H:1V or flatter	3 - 5 feet	5 – 7 feet	3 – 5 feet *
Steeper than 3H:1V (up to 1H:1V)	3 feet *	3 – 5 feet	0

Source: Robbin B. Sotir & Associates, Inc.

* Not recommended alone; use with erosion blankets.

- Live plant material stakes and dead stout or construction stakes are used to anchor the live fascine bundles. Live stakes (see Figure 4.5-I) are at least 24 inches long and between ½ and 2 inches wide. Dead stout stakes are made from 2x4-inch untreated lumber. Stakes are 30 to 36 inches long and cut diagonally across the 4-inch face, tapering to a 1/8- to 1/4-inch tip.
- Stakes must be installed directly through the live fascine bundle to ensure it will not lift up or allow water to move under the installation. Stakes are placed 3 feet apart. Best installation uses dead stout stakes for securing the fascine bundles, with live stakes installed between fascine rows.
- Place soil along the sides of the live fascines in and around the branches and at each stake to provide for growth media.
- Foot-compact all soils around all fascine bundles, dead stout stakes, and live stakes.

Maintenance Specifications

- All plantings need water and nutritional support during the first 3 years of establishment. Removal of invasive plant species is also required. Ensure that there is a responsible party for this ongoing plant maintenance.

Removal Specifications

- These systems are permanent measures.

Installation Tips

- Store vegetation in water until it is bound and installed.

- Install live fascines during the dormant season.
- Ensure that soil is adequately worked around the bundle.
- Do not completely bury the live fascine. The top branches should be visible.

Note: If a live fascine fails to grow, it still acts as a mechanical barrier to slope flows.

Signs of Failure

Symptoms	Cause	Solution
Fascine has dislodged or is gone.	<ul style="list-style-type: none"> • Fascine was not appropriately anchored. 	<ul style="list-style-type: none"> • Replace bundles and re-anchor with additional stakes and ensure that live fascines are secured into the trench. Repack soil. • Replace missing fascines with adequate anchoring. • Verify that the stream or runoff flow problem has been corrected.
Live fascines are not growing.	<ul style="list-style-type: none"> • Lack of contact with live fascine and soil. • Live fascines are dead because of lack of water or nutrients and/or anaerobic soil conditions. 	<ul style="list-style-type: none"> • Rebury, adding water and nutrients if needed. • Seed or add live stakes to the streambank to provide for vegetative growth.

Figure 4.5-I Live Fascines

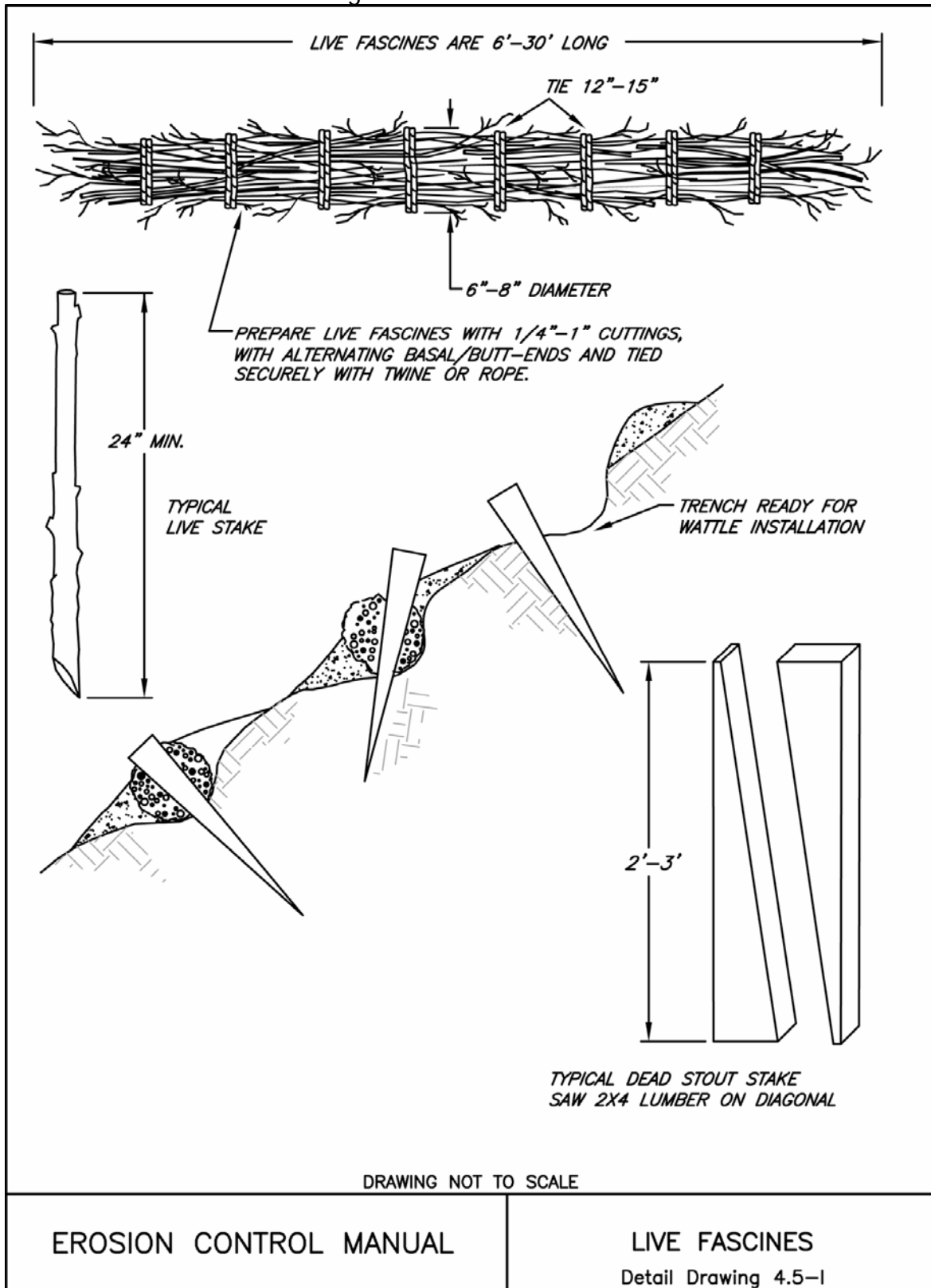
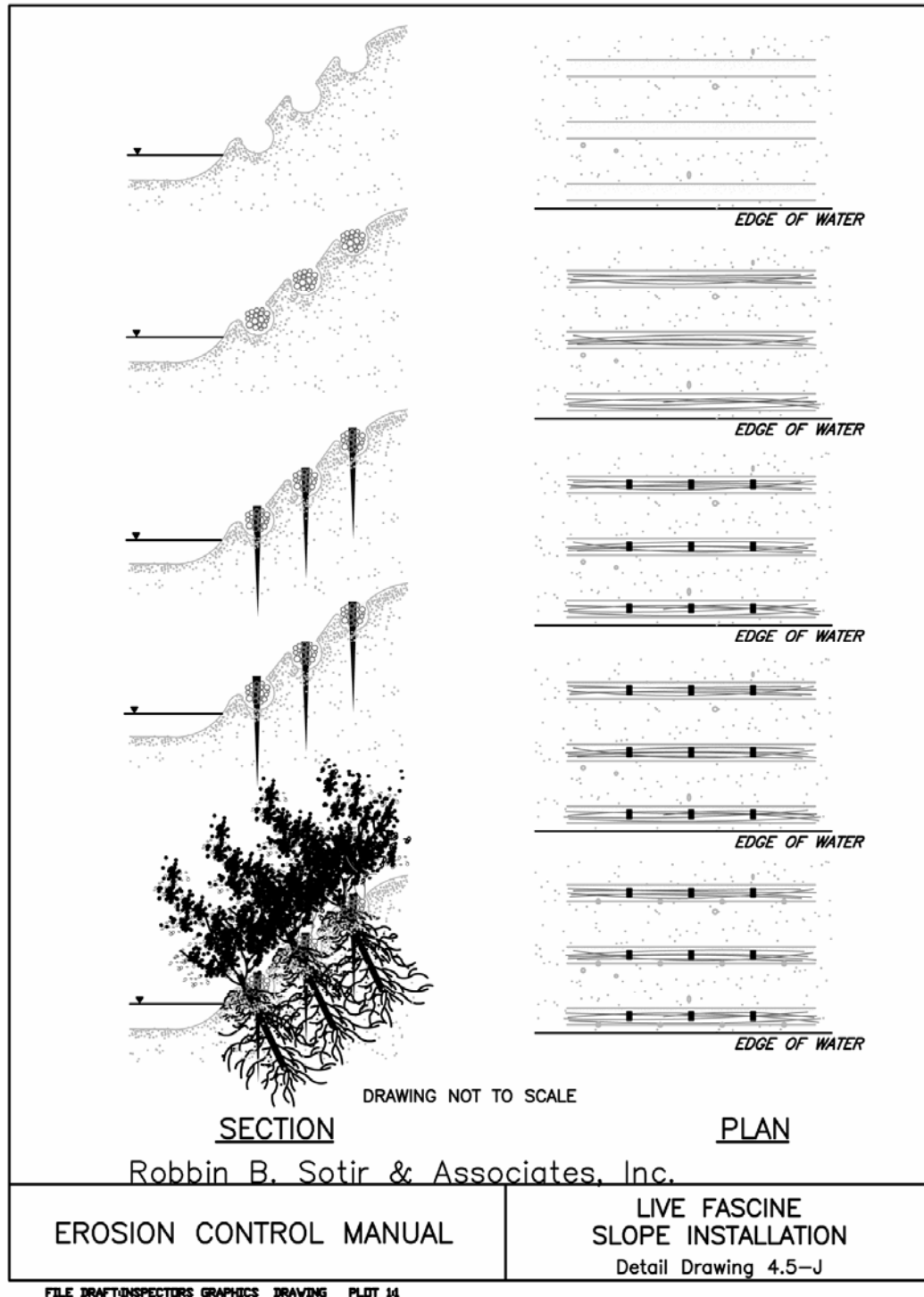


Figure 4.5-J Live Fascine Slope Installation



4.6 INSTREAM BMPS

Instream BMPs are designed to provide sediment trapping for projects that must take place within the waterway. Projects that cross or otherwise work within the waterway shall strive to limit the amount of work that occurs within the water flow line. Measures that can reduce the amount of instream work include working from bank areas, diverting the stream around work areas, or scheduling for seasons of no or limited flows.

4.6.1 Instream Sediment Trapping Devices

Definition

Instream sediment trapping devices include both floating materials (turbidity curtains) anchored to the watercourse bottom and instream sediment collection mats that run along the watercourse bottom (such as the Sedimat™). These materials are specifically designed to limit sediment transport impacts within a body of water.

Purpose

These devices provide sedimentation protection for instream, bank, or upslope ground disturbance, dredging, or filling within a waterway.

Conditions Where Practice Applies

- Use these BMPs in a flowing watercourse, lake, or other area of water impoundment or flow that has aquatic resources that need protection.

Note: Various state permits (e.g., Division of State Lands, Department of Environmental Quality) or federal permits (e.g., U.S. Army Corps of Engineers) may be needed for these installations.

Shall Not Be Used

- Turbidity curtains shall not be installed across streams unless they are specifically engineered to withstand expected flows and approved by applicable agencies.

Design Criteria/Specifications

These BMPs are designed and selected for specific flow conditions. For sites with flow velocities or currents greater than 5 feet per second, a qualified engineer and product manufacturer shall approve of the use.

Turbidity Curtains

- See Figures 4.6-A, 4.6-B, and 4.6-C for detail drawings.

- Turbidity curtains shall be installed parallel to the flow of the watercourse, allowing for 10 to 20 percent variance in the straight-line measurements. Allow for at least 50 feet between joints in the curtain and no more than 100 feet between anchor or stake locations.
- Multiple concentric curtains, in some cases both top-down and bottom-up, may be necessary to fully contain sediment during in-water work.
- Turbidity monitoring shall be conducted to evaluate curtain effectiveness, and contingency measures shall be implemented immediately if suspended sediment escapes in excess of allowable limits.
- Turbidity curtains shall extend the entire depth of the watercourse. In significant wind, wave, or tidal action areas, a 10- to 12-foot depth is the most practical because of fabric and mooring anchor strain from the heavy water and sediment loads.
- For tidal situations or in areas heavily impacted by wind-generated wave action, turbidity curtains shall have slack to follow the rise and fall of the water level without submerging. Curtains shall also maintain adequate flow-through, usually by using heavier woven fabric for the bottom sections of the curtain.
- Materials shall be of strong, heavyweight materials that have UV inhibitors. The tensile strength shall be sufficient to withstand predicted flows. All material seams and line attachments shall be sewn or vulcanized welded into place. Materials shall be of bright colors, when applicable, to attract attention of boaters or swimmers using areas near the worksite. Flotation devices for turbidity curtains shall be flexible, buoyant units contained in an individual flotation sleeve or collar attached to the curtain. Flotation devices shall be secured to prevent shifting and ensure proper flotation along the entire length of the curtain.
- Turbidity curtains shall be anchored by vinyl-sheathed steel cable at the top, with a breaking strength as per engineer specifications, but 10,000 pounds at the minimum. At the bottom, a load line with chain incorporated into the bottom hem of the curtain shall be used for ballast to hold the curtain vertical.
- Shoreline turbidity curtain anchors and instream sediment mats shall be anchored by chains, 2x4-foot wood, or 1.33 pounds/lineal foot metal stakes. Bottom anchors for turbidity curtains shall hold the curtain in position and may be any of the following anchor types: plow, fluke, mushroom, or grappling hook. All instream anchors shall have a floating anchor buoy or other identifying mark.
- Best installation is achieved by setting the upstream anchor points first, then unfurling the fabric, letting the flow carry the fabric downstream or to a vertical position for turbidity curtains.
- Soils shall be allowed to settle for a minimum of 6 to 12 hours before BMP removal or cleaning. All cleaning operations shall also use good sediment control practices. Consider

sizing materials adequately to allow maintenance to occur only before removal and not throughout the project.

Sediment Collection Mats

- Instream sediment mats can be aligned either direction along the watercourse bottom, as long as the upstream mat overlaps the downstream mat (like a drainage ditch erosion control blanket installation, see Figure 4.5 D). Ensure that the upstream edge is firmly trenched in to prevent flows from going under the mat. Mats shall cross the entire stream and be staked or use stones to keep them in place. Follow the manufacturer's specifications for the length of mat needed for the site's flow rate.

Maintenance Specifications

- Inspect turbidity curtains as least daily during in-water work. Immediately repair floats, fabric, or seams to maintain a fully intact barrier.
- Follow the manufacturer's instructions for fabric and material repair.

Removal Specifications

- All materials shall be removed at low flows and in a way that scoops and traps sediments within the fabric. The removal area shall be clear of any obstructions that could tear the fabric.
- For mats, consider rolling up from the downstream end to trap silts in the mat roll. For curtains, consider pulling the bottom line and top lines in together like a parachute to pull soils ashore.
- Spoils shall be reused and controlled for erosion on a nearby bank or upland area needing stabilization. Sediment mats can be reused for bank stabilization.

Signs of Failure

Symptoms	Cause	Solution
Turbid water releasing from curtain.	<ul style="list-style-type: none"> • Bottom anchor is loose or gone. • Joints/overlaps are loose. • Floatation is gone/diminished. • Curtain material is torn. 	<ul style="list-style-type: none"> • Repair/replace parts as needed. • Reevaluate curtain strength versus strength of water flows.

Figure 4.6-A Turbidity Curtain – Plan View

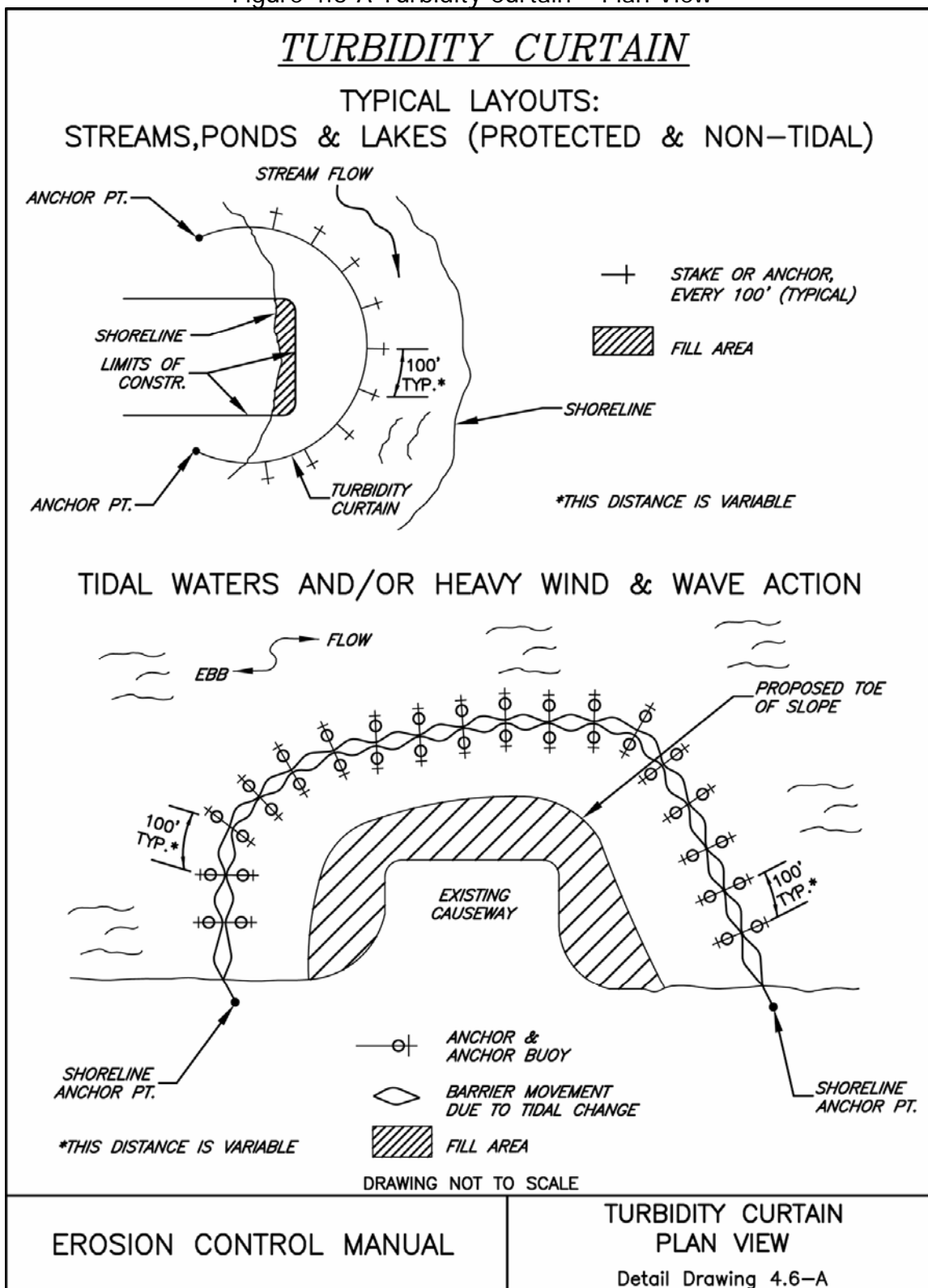


Figure 4.6-B Turbidity Curtain Connections

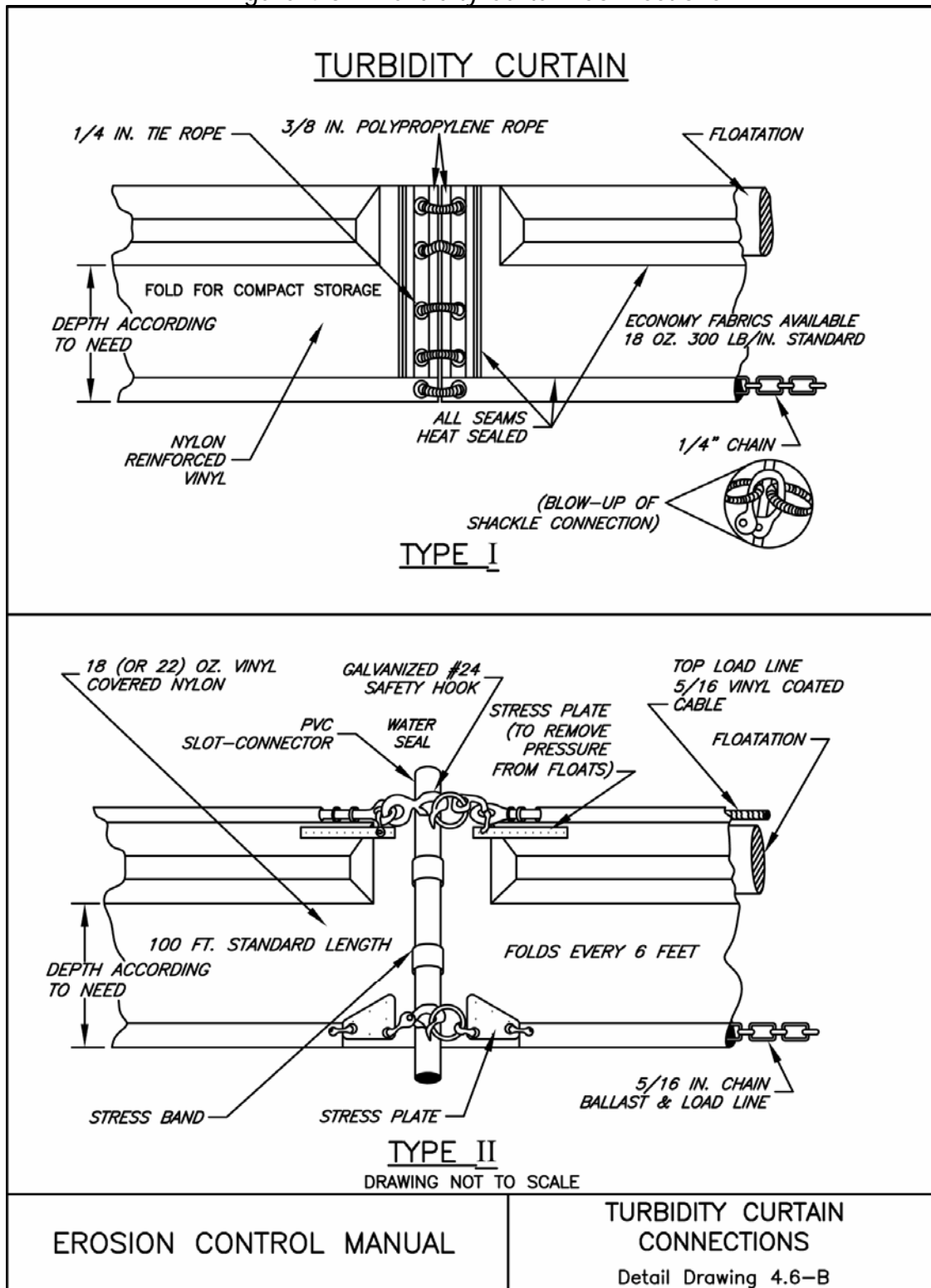
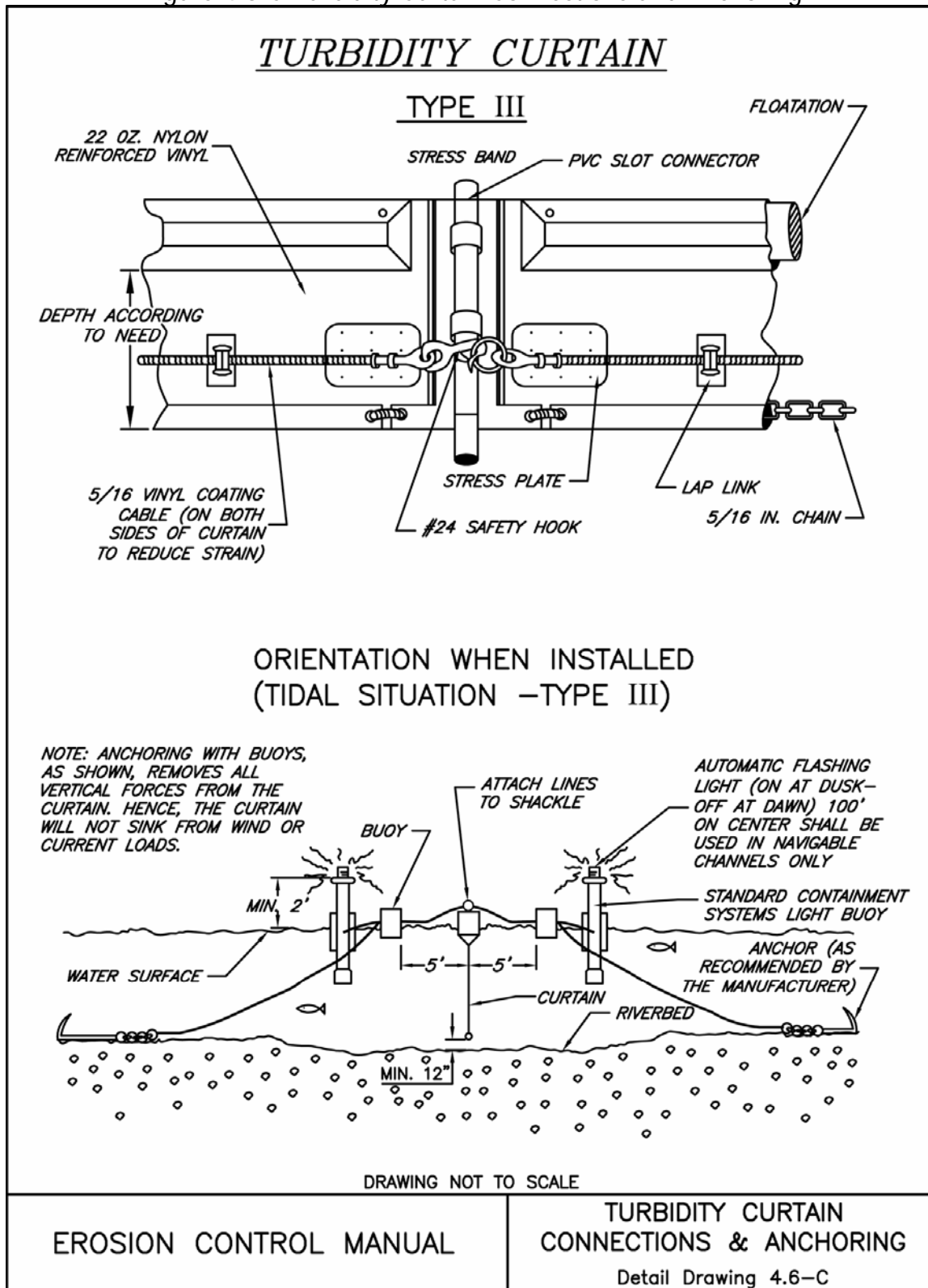


Figure 4.6-C Turbidity Curtain Connections and Anchoring



5 DEVELOPMENT ACTIVITY CONTROLS

5.1 INTRODUCTION

Many development activities can generate other pollutants besides sediment. The BMPs described in this chapter are designed to give guidance to the contractor in controlling liquid and solid waste materials during development activities. Most of the BMPs have a strong planning component and need to be considered during site layout and reflected on construction plans. The contractor is encouraged to use BMPs that emphasize prevention rather than BMPs that control pollutants after the fact.

5.2 CONSTRUCTION POLLUTANTS

Although sediment is the most prominent pollutant generated at a development site, a number of other wastes, byproducts, and construction site materials can be harmful to worker health, streets and stormwater conveyance systems, and streams or other waterways. Table 5.2-A describes some of the most common site pollutants generated by development activity and some of the impacts of those pollutants. It also gives general guidance on what to do with the materials.

In general, good housekeeping practices are the main controls used for development-related activities. Work rules and practices are created to reinforce pollution prevention and discharge control to all workers at the job site. Worker education and training are essential.

Table 5.2-A. Common Construction Site Pollutants

Activity	Waste	Impacts	Guidance
Demolition Waste	Asbestos	<ul style="list-style-type: none"> Human hazard. 	<ul style="list-style-type: none"> Get a DEQ permit prior to removal. Assure that waste is disposed of at a landfill approved to take asbestos.
	Solid waste	<ul style="list-style-type: none"> Poor aesthetics. Dust. Tripping hazard. Inlet blockage. Reduces instream oxygen. Impairs fish movement and feeding. 	<ul style="list-style-type: none"> Solid waste can degrade your site in the eyes of neighbors and potential buyers. Control wastes in a designated area or facility, and recycle as much as possible to lower landfill fees.
Equipment Operations	Antifreeze	<ul style="list-style-type: none"> Reduces instream oxygen. Impairs groundwater resources. Toxic to pets and children. 	<ul style="list-style-type: none"> Recycle, if possible. If not, contact local sewerage agency for discharge limitations and approvals. DO NOT pour into storm drains or on ground.
	Gasoline Hydraulic fluid Oils (gear, lubricating or engine) Brake fluid	<ul style="list-style-type: none"> Flammability hazard for site and sewer workers. Can instantly kill fish, impair feeding, or smother gravels. Reduces instream oxygen. 	<ul style="list-style-type: none"> Minimize amount of fuels, oils, and other materials needed onsite. For small, short-duration projects, consider fueling and maintaining vehicles back at your company yard or other offsite controlled location at the end of the project. Store fuels or oils in designated and marked areas. Provide berms or protection from construction traffic. Provide adequate spill control structures and training. Show all equipment fueling and maintenance sites on your Erosion, Sediment, and Pollutant Control Plan (ESPCP) and add notes to plan defining proper procedures to follow in these locations. Designate all equipment fueling and maintenance sites on your ESPCP and add plan notes on the procedures to be followed in those locations.

Table 5.2-A (continued)

Activity	Waste	Impacts	Guidance
Equipment Maintenance	Used oil	<ul style="list-style-type: none"> May be a hazardous waste. (Same as Equipment Operations, above.) 	<ul style="list-style-type: none"> Recycle or reuse if possible. If not, do a hazardous waste determination to determine appropriate level of disposal.
Concrete Work	Saw cutting Extra materials disposal Concrete finishing	<ul style="list-style-type: none"> Reduces instream oxygen. 	<ul style="list-style-type: none"> Control wastes onsite in defined area. Dispose of wastes as per manufacturer. DO NOT allow wastes or curing materials to enter storm drain.
	Sealants	<ul style="list-style-type: none"> Flammability hazard for site and sewer workers. May be a hazardous waste. Reduces instream oxygen. 	<ul style="list-style-type: none"> Do not buy or mix more than needed. Paint excess out on scraps, let dry and dispose of in dumpster. Any leftover materials should be disposed of at approved facility. DO NOT allow wastes or curing materials to enter storm drain.
	Additives and curing materials	<ul style="list-style-type: none"> Flammability hazard for site and sewer workers. May be a hazardous waste. (Same as Gas/ Hydraulic fluid, above.) 	<ul style="list-style-type: none"> Do not buy or mix more than needed. Paint excess out on scraps, let dry and dispose of in dumpster. Any leftover materials should be disposed of at approved facility. DO NOT allow wastes or curing materials to enter storm drain.
Framing and Roofing	Wood preservatives	<ul style="list-style-type: none"> Flammability or toxic hazard for site and sewer workers. Can directly kill fish. Reduces instream oxygen. 	<ul style="list-style-type: none"> Consider using alternatives to wood – e.g., plastic or plastic mixed with wood – for areas exposed to the elements. If you must use wood, minimize heavily preserved or pressure treated lumber. Buy materials with preservatives already applied at the factory. Do not buy or mix more than needed. Leftover materials should be disposed of at an approved facility (see guidance for Demolition Waste, above).

Table 5.2-A (continued)

Activity	Waste	Impacts	Guidance
	Resins	<ul style="list-style-type: none"> • Flammability or toxic hazard for site and sewer workers. • Reduces instream oxygen. 	<ul style="list-style-type: none"> • Do not buy or mix more than needed. • Completely dry out all containers and dispose of in dumpster. • Any leftover liquid must be disposed of at approved facility.
	Solid waste	(Same as Demolition Waste, above.)	<ul style="list-style-type: none"> • See above. Consider vacuuming or lining gutters to collect shingle debris. • DO NOT rinse shingle debris down downspouts.
Plumbing HVAC	Solid waste	<ul style="list-style-type: none"> • Metal debris can leach long-term harmful chemicals to streams. • Poor aesthetics. • Dust. • Tripping hazard. • Inlet blockage. • Reduces instream oxygen. • Impairs fish movement and feeding. 	<ul style="list-style-type: none"> • See above.
	Solvents/ degreasers	<ul style="list-style-type: none"> • Flammability hazard for site and sewer workers. • Reduces instream oxygen. • Impairs groundwater resources. 	<ul style="list-style-type: none"> • Reuse and recycle when at all possible. • Contain materials on impervious surfaces. • DO NOT rinse materials to storm drains or onto the ground. Dispose of materials through an approved recycling or disposal facility.
Painting	Paint thinner	Same as Solvents.	<ul style="list-style-type: none"> • Same as Solvents. Let thinners settle and strain out materials to allow for reuse. • Dispose of material only after it is too contaminated to strain any more.
	Paints	<ul style="list-style-type: none"> • Flammability or toxic hazard for site and sewer workers. • Reduces instream oxygen. 	<ul style="list-style-type: none"> • Reuse and recycle when at all possible. • Latex: Paint excess out on scraps, let dry and dispose of in dumpster. Check with fire marshal for oil-based disposal. Any leftover materials should be disposed of at approved facility.

Table 5.2-A (continued)

Activity	Waste	Impacts	Guidance
Landscaping	Fertilizer	<ul style="list-style-type: none"> Increases algae growth. Reduces instream oxygen. Affects pH balance. 	<ul style="list-style-type: none"> Design sites with native and other plants that need little or no additional soil amendments. Use composts or organic fertilizers instead of nitrogen- and phosphorus-based fertilizers when at all possible. Control fertilizer piles, providing protection from rain and runoff if needed. Till all fertilizers well into the topsoil layer.
	Pesticides/ herbicides	<ul style="list-style-type: none"> May create health hazard for site and sewer workers. Can kill fish on contact or mutate over longer periods of time. Can impair groundwater resources. 	<ul style="list-style-type: none"> Design sites with native and other plants that need little or no horticultural chemical care. Use biological and structural controls before resulting to chemical controls. If chemical control is needed, consider using organic compounds. Do not mix more than is needed for the site. Time application to specifically address pest or condition. Watch overspray, especially over water.

Source: Oregon Department of Environmental Quality (DEQ)

Note: For adequate disposal, refer to Metro's guide for construction waste, or call Metro's Resource Information Center at 503-234-3000 for more information. Metro has a hazardous waste acceptance program for Conditionally Exempt Generators (CEGs), for which many construction companies may qualify.

5.2.1 Hazardous and Special Wastes

As noted in Table 5.2-A, some construction pollutants may require additional measures to comply with hazardous waste and materials handling and disposal laws. In general, the following materials may require additional controls and/or consideration during use and disposal:

- Oil/water-based paints
- Form oil and used oils
- Sealers
- Degreasers
- Petroleum products
- Vehicle batteries
- Pesticides and herbicides
- Fluorescent and high-density lamps
- PCBs (polychlorinated biphenyls – found in old electrical equipment)
- Asbestos (in insulation, tiles, joint cements and caulks, stucco, and a variety of materials)
- Lead (in paints, roofs, tank linings, plumbing soft solder)
- Contaminated soils

All contractors are encouraged to call the local DEQ hazardous materials program for more information about regulations that may be relevant to their development site (1-800-452-4011).

5.3 DEVELOPMENT ACTIVITY CONTROL BMPs

Development activity control BMPs are designed to prevent or reduce the discharge of pollutants to stormwater from site activities that support development or ground disturbance. In general, these BMPs stress:

- Using soil erosion controls to keep pollutants from washing off.
- Enclosing or covering material storage areas to prevent contact with stormwater runoff.
- Using good housekeeping practices.
- Using safer alternative products.
- Training employees.

These BMPs shall be used for all repair, renovation, and remodeling of existing structures, or where hazardous materials are to be used on the worksite. These BMPs strive to control raw materials, byproducts, finished products, containers, and material storage areas exposed to wind, rain, or runoff that can contribute to water pollution. All sites shall ensure that workers know the rules and practices of the worksite and that there is a strong effort to enforce them.

All locations for materials storage, hazardous materials use, or washing operations shall be designated on the site's Erosion, Sediment, and Pollutant Control Plan (ESPCP) (see Chapter 3). State and federal agencies may require additional pollution control measures.

5.3.1 Dewatering

Purpose

To assess and appropriately dispose of rising groundwater or rainwater from excavations and other collection areas.

Conditions Where Practice Applies

Public or private properties with:

- Foundation work excavations.
- Utilities and infrastructure installation and repair projects, including installation, repair, and maintenance of:
 - Electrical conduits.
 - Vaults/tanks.
 - Sewer and storm drain systems.
 - Phone and cable lines.
 - Gas or other fuel lines.
- Other excavations or graded areas requiring dewatering.

Design Criteria/Specifications

Specific site controls may be required to ensure that dewatering discharges do not impact local sewers and streams from increased flow volumes, flow velocities, or pollutant loads.

Depending on season, flow rate, volume, or residual contamination:

1. Discharge may be allowed to the ground in a manner that ensures that no runoff leaves the site. This may require a permit or other authorization from the City and/or the state drainage authority.
2. Discharge may be allowed to the storm drain system. All discharges shall meet the total suspended solids (TSS) and/or turbidity levels required by the City's Bureau of Environmental Services (BES). A permit or letter of authorization with discharge restrictions may be required. Call 503-823-7122 for more information.
3. Discharge may be allowed to the sanitary sewer. A permit or letter of authorization with discharge restrictions may be required. Call BES at 503-823-7122 for more information.

In extremely rare instances, it may be required to haul pumped groundwater or impounded stormwater offsite for treatment and disposal at an appropriate waste treatment facility.

- **Site Assessment:** The site shall be assessed for the issues listed below to help BES determine which discharge option to approve:
 - *Assess water clarity:* If the water is cloudy or turbid, there are dissolved and/or settleable solids in the water that must be filtered or settled out before discharge.
 - *Determine if contaminants are present in impounded waters:* Check for odors, discoloration, or an oily sheen. Review the Phase I environmental assessment for the property to determine if contamination is likely. Check any soils and/or groundwater testing results.
 - *If contamination may be or is present:* A certified laboratory must test proposed discharge waters, with the results submitted to BES. Sampling and testing requirements will be determined on a case-by-case basis, depending on the site history or suspected pollutants. Contact BES before testing to get assistance in identifying the required parameters of concern and any specific sampling requirements. After review, BES will specify where the discharge point is (storm or sanitary sewer) and if any pretreatment is required before discharge.
- **Sediments shall be settled before discharge.** All settling systems shall be engineered and adequately sized for site conditions. In general, settling and filtering options include but are not limited to:

- Containment in a pond structure until water is clear. Place the pump in a gravel bed at the bottom of the pond.
 - Pumping to a Baker tank or other settling tank with sampling ports.
 - Filtering through a sieve or other filter media (e.g., swimming pool filter). Simple onsite filter systems can be constructed by wrapping the ends of the suction and discharge pipes with filter fabric; discharging through a series of drums filled with successively finer gravel and sand; and other filtering techniques such as those described in the Storm Drain Inlet Protection section.
 - Manufactured bags or other systems. These systems do not always work on fine clay soils and will be allowed for use only where approved.
 - Application of a polymer/flocculant where its use has been approved.
- Filtered material shall either be dried and reused onsite in a mixture with other site soils or appropriately disposed of, based on the nature and levels of any contaminants present.

Maintenance Specifications

- Remember to check filtering devices frequently to make sure they are unclogged and operating correctly. Adjustments may be needed, depending on the amount of sediment in the water being pumping.

Removal Specifications

- Systems shall be filled in or otherwise removed when permanent dewatering controls are in place and connected to an approved treatment and receiving system.

5.3.2 Spill Prevention and Control BMPs

Purpose

To prevent or minimize accidental discharges or longer-term leakage of pollutants to stormwater systems and/or the ground.

Conditions Where Practice Applies

- Any area where vehicle and equipment maintenance, fueling, or washing operations occur.
- Any area where storage of more than 55 gallons of liquid materials or 80 pounds of dry material and/or wastes occurs.

Design Criteria/Specifications

Use the following BMPs to control leaks and spills onsite:

- Prepare a Spill Response Plan for the site. Post spill hotline notification numbers, have spill kits on hand, and train employees what to do in the event of a spill. Be sure that all employees know to call the BES Spill Hotline at 503-823-7180 (open 24 hours a day, 7 days a week) to report spills that get offsite to local waterways or into City systems. Provide specific cleanup instructions for the material present or likely to be present on the site. Assign a worker to be responsible for overall site response and cleanup.
- Specify designated areas for liquid storage and for all vehicle and equipment maintenance, fueling, and washing operations. Sites shall be well marked and located away from drainage courses and systems. In no case shall any liquid storage drum, tank, or other vessel (including portable toilets) be stored over storm drains.
- Provide secondary containment for all vehicle and equipment fueling, maintenance, operation, and liquid storage areas. Containment can include any or all of the following:
 - Covers or canopies
 - Reverse grading
 - Area berms to contain flows
 - Drain pans or drop cloths to catch spills or leaks when removing or changing fluids
 - Holding tanks or structures
 - Sand stabilization and containment piles (see Figure 5.3-A)
- Size secondary holding or containment tanks and structures to hold 10 percent of total storage volume of all containers present in the work area or 110 percent of the volume of the largest container in the area.

- Promptly transfer used fluids to the proper waste or recycling drums. Do not leave full drip pans or other open containers lying around.
- Provide adequate traffic protection for all designated containment areas. Protection can include berms, flags, pinions, fencing, or jersey barriers.
- Use adsorbent materials (pads, kitty litter, etc.) on small spills, rather than hosing down or burying spilled materials. Ensure that adsorbent materials are collected and disposed of promptly.
- Verify the appropriate recycling or disposal location for the adsorbent material.
- Ensure that all vehicle or equipment parts (oil filters, batteries, etc.) are appropriately drained, stored, and/or disposed of and not left onsite to seep materials to the ground or into storm drains.

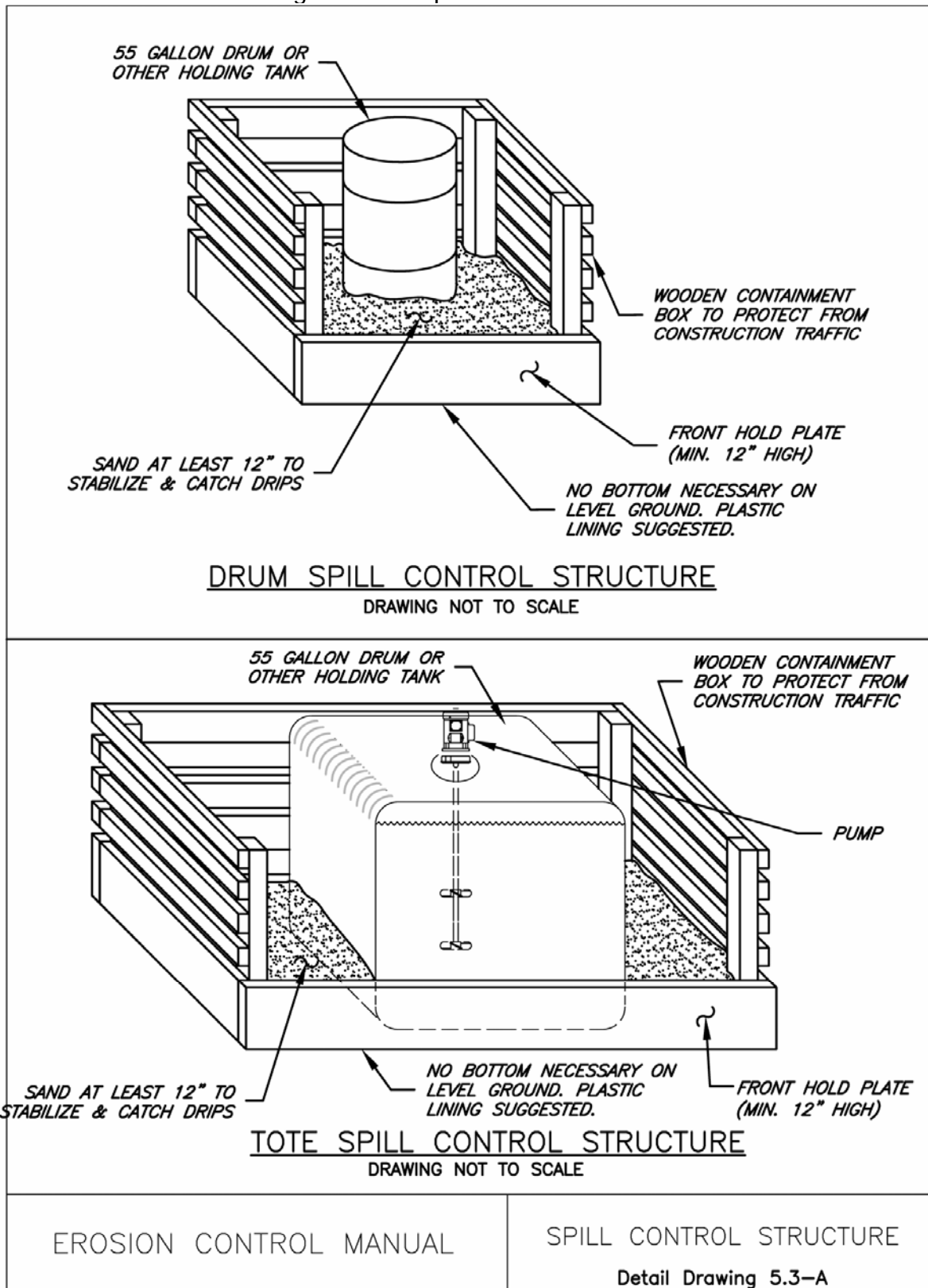
Maintenance Specifications

- Periodic inspection and maintenance of storage areas shall be indicated as part of the Erosion, Sediment, and Pollutant Control Plan (ESPCP) and recorded as part of the inspection report.

Removal Specifications

- Systems shall be used until empty, or pumped into hauling trucks so structures can be disassembled. Any newly exposed soils shall be covered with appropriate erosion control materials.

Figure 5.3-A Spill Control Structure



5.3.3 Solid Waste and Materials Management

Purpose

To provide designated waste collection areas and containers to prevent or reduce the discharge of windblown and floatable pollutants from construction or landscaping activities.

Conditions Where Practice Applies

- Construction sites, both large and small: commercial, residential, utilities, and public improvements.
- Specific worksite areas with hazardous or recyclable waste streams.
- Demolition projects.
- Landscaping projects.

Design Criteria/Specifications

- Evaluate waste likely to be generated at the site. Determine which wastes will warrant tighter controls because of their hazardous nature and which wastes are reusable or recyclable.
- Consider buying some materials in bulk or in alternative, reusable containers to cut down on packaging wastes.
- Select designated waste collection areas onsite. Collection areas may be specific to each part of the operation – e.g., a metal recycling area to contain HVAC, plumbing, or framing metal wastes. Be careful about siting waste areas in the street or adjacent to other properties; there may be street permit or building code issues. Consider locating these receptacles adjacent to or within the site's rock entry access to allow for storage on a compacted base and easy removal of wastes.
- Provide an adequate number of containers with lids or covers that can be placed over the containers to keep rain out or to prevent loss of wastes when it is windy. Make sure that dumpsters are used only for wastes approved for disposal in construction or municipal landfills. All hazardous or special wastes shall be segregated from standard trash and construction debris.
- Provide a waste receptacle for food-related trash and wastes.
- All building projects in Portland with a permit value of \$50,000 or more (including construction and demolition phases) are required to separate and recycle certain materials from the job site. The general contractor is responsible for ensuring recycling at the job site, including recycling by subcontractors, and for completing a Pre-Construction Recycling Plan Form. Contact the City's Office of Sustainable Development at 503-823-7222 for more information.

- When remodeling or facility demolition work occurs, all structures shall be assessed for old contamination issues, such as asbestos and lead. These and other materials require special waste handling and approval. Contact Multnomah County and Metro for more information.

Soil Management

- Stockpiles of contaminated soils shall be covered with temporary plastic film or sheeting to prevent stormwater from coming into contact with them.
- Stockpiles shall have a containment barrier on all four sides of the perimeter to prevent stormwater run-on and material runoff. Barriers can consist of concrete curbing, silt fencing, or other berming material, depending on the activity, size, and resources available.
- Areas under stockpiles of contaminated soils are not required to be paved. However, an impervious layer shall be placed beneath the stockpile to protect uncontaminated areas from potential leachate.

Landscape Materials Management

- Materials shall not be stored in the right-of-way for more than 24 hours.
- Cover bulk materials with tarps to prevent infiltration of rainfall or windblown migration of materials.
- Place bulk materials on tarps to prevent leaching of dissolved materials into the ground or into stormwater runoff.
- Surround material piles with berms to prevent migration of material.

Solid Waste Collection and Containment Recommendations for Specific Sites

- When working on roofs, line the gutter with fabric, plastic, or other materials to collect wastes, or sweep or wash the gutter and trap the particles at the outlet of the downspout. A sock or geofabric placed over the outlet may effectively trap roofing wastes.
- Recycle used asphalt or concrete. Consider onsite grinding and reuse for sub-base, as approved by the City.

Maintenance Specifications

- Salvage or recycle any useful material. For example, trees and shrubs from land clearing can be used as a brush barrier or can be processed into wood chips, then used as mulch on graded areas.
- Collect site trash daily, especially during rainy and windy conditions. Remember to check erosion and sediment control devices, since they tend to collect floatables and litter. Remove

this solid waste promptly. Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.

- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to the trash-hauling contractor.

Removal Specifications

- Trash collection and recycling facilities shall be one of the last measures removed from the site. Any exposed soils shall be covered with appropriate erosion control materials.

5.3.4 Vehicle and Equipment Fueling

Purpose

To establish designated areas and preventative BMPs that prevent fuel spills and leaks and reduce impacts to stormwater and the ground.

Conditions Where Practice Applies

- Development sites with fueling operations.

Design Criteria/Specifications

Note: It is assumed that all offsite fueling locations generally follow this guidance, but they are regulated by other city and state codes and policies.

Use offsite fueling stations as much as possible. These businesses are usually better designed and equipped to handle fueling operations and spills properly. If fueling must occur onsite, follow all of the spill prevention procedures outlined earlier in this manual.

- Cover, reverse grade, and provide secondary containment whenever possible.
- Locate fueling facilities on impervious areas when at all possible. If paving or concrete pads are unavailable, locate facilities on highly compacted soils and/or gravels.
- Avoid mobile fueling of mobile construction equipment around the site when possible; instead, transport the equipment to designated fueling areas.
- Discourage “topping-off” of fuel and other fluid tanks.
- Install vapor recovery nozzles to limit worker exposure to vapors, protect air quality, and help control drips.
- Ensure that dispensing mechanisms are either small enough to adequately fill the receiving device or have appropriate shutoff valves or other controls. Provide appropriate signage as necessary.
- Train staff in proper use, cleanup, and spill response procedures.
- Ensure that contractor staff have proper and adequate spill response materials onsite.
- Require staff to attend all fuel nozzles during the entire fueling operation. **Unattended fueling operations are prohibited.**

Maintenance Specifications

- Maintain dispensing devices per the manufacturer's instructions. Inspect them often, and log when devices have been cleaned or otherwise serviced.
- Use dry methods to clean fueling areas. If using water to clean, install a temporary plug or containment device in the downstream drain. Pump out accumulated waters, treat, and dispose of properly.

Removal Specifications

- Systems shall be used until empty, or pumped into hauling trucks so structures can be disassembled. Any newly exposed soils shall be covered with appropriate erosion control materials.

5.3.5 Vehicle and Equipment Maintenance

Purpose

To provide offsite facilities and designated onsite areas that help prevent or reduce the discharge of pollutants to stormwater from vehicle and equipment maintenance.

Conditions Where Practice Applies

- Development sites with vehicle maintenance activities.

Design Criteria/Specifications

Note: It is assumed that all offsite vehicle and equipment repair locations generally follow this guidance, but they are regulated by other city and state codes and policies.

Use offsite repair/maintenance shops as much as possible. These businesses are better designed and equipped to handle repair materials and wastes properly. If vehicle repair and maintenance must occur onsite, follow all of the spill prevention procedures outlined earlier in this manual.

- Cover, reverse grade, and provide secondary containment whenever possible.
- Use wipe-downs or other dry methods to clean vehicles and equipment often. Do not allow excessive buildup of oil and grease that may require harsher chemical or other liquid cleaning processes to remove buildup.
- Check all incoming vehicles and equipment for leaking oil and fluids or worn hoses and other parts.
- Store any vehicles awaiting repair or maintenance in designated, and preferably paved, areas. If storage is for over a month, drain all fluids from the vehicle or equipment and store or dispose of liquids appropriately.
- Conduct all washing operations in designated, and preferably paved, areas. Power washing of parts, vehicles, or equipment will likely require pretreatment of wash water for oils, grease, detergents, and temperature before discharge. Discharge will likely be to the sanitary sewer or a dead-end sump. Contact the BES for more information and for discharge approvals.
- Segregate, reuse, or recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic and transmission fluids. Use an approved recycling or disposal company for all vehicle and equipment wastes that could potentially be considered hazardous.
- Collect and evaluate all wash water in order to obtain authorization for discharge either onsite or to an approved offsite disposal system. Wash water must never go to a stormwater or groundwater disposal system.

Maintenance Specifications

- Use dry methods to clean equipment repair/maintenance areas. If using water to clean, install a temporary plug or containment device in the downstream drain. Pump out accumulated waters, treat, and dispose of properly.

Removal Specifications

- Any established structures shall be thoroughly cleaned before disassembly. Any newly exposed soils shall be covered with appropriate erosion control materials.

5.3.6 Concrete Waste Management

Purpose

To prevent or minimize the discharge of pollutants from concrete waste to stormwater.

Conditions Where Practice Applies

- Concrete pours, such as foundation, footing, or pile sites.

Design Criteria/Specifications

Saw Cut Slurry Management

- Locate all nearby storm drain inlets, culverts, and catch basins through which slurry discharges may enter a waterway. If within access of a storm drain inlet, block the path to the nearest drain. Either divert flows or use berms at inlets to pool water away from drains. Another option is to seal or plug the inlet.
- Slurry and sediment from saw-cutting operations shall be confined to the immediate work area by using temporary berms or diversion structures. Minimize offsite tracking of slurry by cars and pedestrians.
- Efficiently and effectively collect and remove all slurry and runoff from the saw-cutting operation as soon as possible. Be sure to include removal of any slurry collected in or near the storm drain inlets by pumping to a collection vessel or using a wet/dry vacuum. It may be necessary to use a street sweeper or wash down the area and collect the water. No slurry or wash water is allowed to drain offsite. Slurry and wash water may be disposed of onsite where it can filter into the ground. Otherwise, dispose of all collected slurry and wash water properly. One way is to allow collected slurry to settle and decant the water onto the ground or, with approval, into the sanitary sewer. Dispose of the solids appropriately.

Mixing, Curing, and Hose-off

- Designate materials storage and mixing areas. Store dry and wet materials under cover, away from drainage systems.
- When washing concrete to remove fine particles and expose the aggregate, avoid creating erosion by draining the water to the side into a bermed or level area or into a sediment control structure. Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to the aggregate base stockpile, or dispose of them in the trash.

Disposal of Extra Materials/Truck Washout

- Perform washout of concrete trucks offsite or in designated areas only. Do not wash out concrete trucks into storm drains, open ditches, streets, or streams. Do not allow excess concrete to be dumped onsite, except in designated areas.
- Locate designated washout areas as far from storm drains, open ditches, or water bodies as possible (over 50 feet away is preferred on larger sites). State or federal permits may require more than 50 feet of setback.
- Line entry/exit areas with gravel to catch washout residues leaking from trucks.
- Contain washout runoff in a temporary dead-end sump, pit, or level bermed area large enough to hold liquid and solid wastes. **NEVER** wash out concrete trucks into a storm drain, ditch, or waterway. Facilities shall be designed specifically for the maintenance equipment used, for easy access, and to avoid creation of a confined space.
- Train all applicable employees in proper procedures for washout area use and maintenance.
- An alternative to establishing designated areas is to use plastic-lined drop boxes to hold and dispose of wastes. Ensure that boxes are leak-proof, and clean up any over-splash immediately.
- Establish temporary containment systems, such as totes, for extra materials disposal in areas that are predominantly impervious.

Maintenance Specifications

- Clean out designated washout facilities and areas often. Concrete can set, be broken up, and then disposed of properly.
- Refurbish facilities as needed.

Removal Specifications

- Any established structures shall be thoroughly cleaned before disassembly. Any newly exposed soils shall be covered with appropriate erosion control materials.

5.3.7 Structure Preparation and Painting

Purpose

To prevent or reduce the discharge of pollutants from structure preparation and painting activities to stormwater.

Conditions Where Practice Applies

Building washing is allowed to discharge to the ground as long as there is no discharge to surface waters, storm sewers, or dry wells. These BMPs apply to:

- Building washing and preparation operations.
- Any painting operation.

Design Criteria/Specifications

- The use of acids, bases, metal brighteners, steam, or heated water is prohibited.
- The use of a biodegradable, phosphate-free cleaner with cold water is allowed.
- Discharge to storm sewers is allowed only if no additives (chemicals, soaps, detergents, steam, etc.) are used and best management practices are implemented to minimize sediment and/or debris. This includes, but is not limited to, inlet protection.
- Store paints, preparation and cleaning materials, and equipment in designated areas.
- Storage areas shall be protected to ensure that sediments, leakage, and wastes are prevented from being tracked offsite. Include storage for soiled rags, rollers, and other application and cleanup materials.
- Store materials indoors to protect them from rainfall and wind. When unable to do so, cover the materials with a roof or with suitable temporary plastic or similar material. Portable sheds can provide good materials control, and a lockable structure can also provide good security. Keep outdoor storage containers in good condition. Keep liquids in designated areas, preferably on paved surfaces, with secondary containment measures.
- Storage of flammable materials shall be in accordance with Fire Bureau requirements and regulations.
- Mixing of materials, such as paint, shall be performed indoors, before arriving at a job site, or in a protected designated area. This limits exposure of the material to wind and water.
- Recycle or reuse excess materials whenever possible. Dispose of other waste materials in accordance with regulations that govern the materials. Latex paint may be dried and disposed of in the regular trash.

- Collect solid (paint chips) and liquid wastes from power washing or other structure preparation activities. Collect materials on tarps, canvasses, or other materials.
- Route large quantities of liquid wastes into a collection area where solids can be settled out, liquids decanted, and solids removed and adequately disposed of.
- Avoid or limit activities on rainy or windy days to avoid rinse-off and airborne drift, especially when using hazardous materials. When possible or necessary, enclose or cover preparation or painting operations.
- Use temporary scaffolding to hang drop cloths or draperies to help enclose the work area.
- Use application equipment and methods that minimize overspray.
- Wash water from rinse-out of equipment and brushes shall be discharged into a sanitary sewer, never a storm sewer or stream.

Maintenance Specifications

- Cleanup of equipment shall be performed in an approved location or into an approved sanitary sewer connection. Washout or waste residue shall be prohibited from entering the stormwater system.
- Wash out paint supplies and spray gun cleanout onto a collection cloth, into a collection bucket, or into an approved sanitary connection.
- Work rags, coveralls, tarps, or similar types of equipment shall be stored and disposed of properly. They shall not be left exposed to elements after a work shift. Materials shall not be discarded or left at the worksite.
- Inspect and maintain application equipment often. Periodic inspection and maintenance of storage areas shall be indicated as part of the site's Erosion, Sediment, and Pollutant Control Plan (see Chapter 3) and recorded as part of the inspection report. Check storage areas periodically for leaks and spills, fixing any leaks when they occur. Inform the appropriate authorities of any incidents and cleanups.

Removal Specifications

- Any established structures shall be thoroughly cleaned before disassembly. Any newly exposed soils shall be covered with appropriate erosion control materials.

6 APPENDIX A: UNIVERSAL SOIL LOSS AND REVISED UNIVERSAL SOIL LOSS EQUATIONS

At any construction site, some erosion control measures may have to be designed using the Soil Conservation Service (SCS) Universal Soil Loss Equation. The measures must be designed to achieve a disturbed-area erosion loss of no more than 1 ton per acre per year as calculated by the soil loss equation. To assist you we suggest using one of 2 equations created by the National Resources Conservation Service: the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE). The RUSLE is maintained as a computer program that you can access at

http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm.

Both equations are based on particular site conditions, different types or combinations of erosion control measures desired for a construction site. The erosion control measures outlined in the matrices in section 2.4 are designed to achieve the 1 ton per acre per year goal, based on a typical soil type for the urban Tualatin River basin area.

The SCS Universal Soil Loss Equation or other approved supporting methodology must be used to design the erosion control system. You must submit your design calculations to the Bureau of Development Services (for private projects) or the appropriate bureau section (for public-sector projects) with the proposed erosion control plan, and describe your methodology for determining the amount of soil loss off of your site.

A brief summary of the use of the Universal Soil Loss Equation follows. For more detailed information, Agriculture Handbook No. 537, "Predicting Rainfall Erosion Losses, A Guide to Conservation Planning" (USDA, 12/78) is recommended.

The Universal Soil Loss Equation is:

$$A = R \cdot K \cdot LS \cdot CV \cdot PR$$

where:

A is the computed soil loss per unit area, generally in tons per acre per year.

R is the rainfall and runoff factor. (For the R factor for your area, contact your local National Resource Conservation Service office. The NRCS is the successor agency to the Soil Conservation Service.)

K is the soil erodibility factor and can be found in County SCS Soil Survey manuals, in the table of Physical and Chemical Properties of Soils (K values for Washington County and portions of Multnomah County in the Tualatin Basin are presented in Tables 5 and 6).

LS is the slope-length factor. LS can be determined for a site using the known slope length and percent slope of a site and Table 2.

CV is the cover and management factor. Use 1.0 for a condition of no ground cover during construction. Other CV factors are presented in Tables 3 and 4.

PR is the erosion control practice factor. Use 1.0 for a condition of bare slopes.

Use 0.9 to represent a condition of trackwalking up and down slopes.

The Revised Universal Soil Loss Equation is actually a computer program that evaluates additional, more regional factors, than the older USLE. In general the RUSLE revises or adds the following factors:

Slope Length (LS in the USLE) is more narrowly defined as the distance from the origin of the flow, through the flow path, to the point where deposition begins.

R Factor is also more narrowly defined to the erosivity of the climate at a particular location.

C

C

C Factor also brings in canopy as cover (not just ground covers), surface roughness, root mass and organic material in the soil.

For more information on or to download the RUSLE go to the NRCS web site at

www.itc.nrcs.gov/focs/RUSLE/index.html

www.sedlab.olemiss.edu/rusle/status.

This site will assist you in using the computerized program.

To use the equation to determine the necessary measures to reduce the soil loss, first determine the loss expected from a cleared site without erosion control measures (only calculate erosion losses for cleared and disturbed areas). Then various factors of these equations can be manipulated to represent the effects of using different types and combinations of added erosion prevention and sediment control measures BMPs. and soil losses recalculated until the desired result is achieved. Factors of the equations can be adjusted as follows to represent erosion control measures.

LS can be reduced by reducing slope lengths. This can be achieved by intercepting and re-routing flows uphill of the disturbed area and thus removing their erosive potential entirely from the site, or by adding interceptor dikes or swales in the disturbed area to direct flows from all or part of the area to a sediment trap or pond.

CV can be reduced by using cover practices such as seeding and mulching, erosion control blankets or plastic sheeting.

PR can be reduced by such measures as grooving or stair stepping steep slopes. (Note: design criteria for the erosion control methods noted above are given in Chapter 4.)

The best means of reducing total tonnage of erosion from a site as well as reducing the amount of erosion control measures BMPs required is to minimize the ground area that is cleared and disturbed at any given time.

7 APPENDIX B: RECOMMENDED STANDARD NOTES FOR EROSION CONTROL PLANS

- A. Approval of this erosion, sediment and pollution control plan (ESPCP) does not constitute an approval of permanent road or drainage design (e.g., size and location of roads, pipes, restrictors, channels, retention facilities, utilities, etc.)
- B. The implementation of this ESPCP and the construction, maintenance, replacement, and upgrading of these ESPCP facilities is the responsibility of the applicant/contractor until all construction is completed and approved and vegetation/landscaping is established.
- C. The boundaries of the clearing limits shown on this plan shall be clearly flagged in the field prior to construction. During the construction period, no disturbance beyond the flagged clearing limits shall be permitted. The flagging shall be maintained by the applicant/contractor for the duration of construction.
- D. The ESPCP facilities shown on this plan must be constructed in conjunction with all clearing and grading activities, and in such a manner as to insure that sediment and sediment laden water do not enter the drainage system, roadways, or violate applicable water standards.
- E. The ESPCP facilities shown on this plan are the minimum requirements for anticipated site conditions. During the construction period, these ESPCP facilities shall be upgraded as needed for unexpected storm events and to ensure that sediment and sediment-laden water do not leave the site.
- F. The ESPCP facilities shall be inspected daily by the applicant/contractor and maintained as necessary to ensure their continued functioning.
- G. The ESPCP facilities on inactive sites shall be inspected and maintained a minimum of once a month or within the 24 hours following a storm event.
- H. Stabilized construction entrances shall be installed at the beginning of construction and maintained for the duration of the project. Additional measures may be required to insure that all paved areas are kept clean for the duration of the project.

Standard Notes for Sediment Fences:

- 1. The filter fabric shall be purchased in a continuous roll cut to the length of the barrier to avoid use of joints. When joints are necessary, filter cloth shall be spliced together only at a support post, with a minimum 6-inch overlap, and both ends securely fastened to the post, or overlap 2 inch x 2 inch posts and attach as shown on detail sheet 4-2A.
- 2. The filter fabric fence shall be installed to follow the contours where feasible. The fence posts shall be spaced a maximum of 6 feet apart and driven securely into the ground a minimum of 24 inches.
- 3. The filter fabric shall have a minimum vertical burial of 6 inches. All excavated material from filter fabric fence installation, shall be backfilled and compacted, along the entire disturbed area.

4. Standard or heavy duty filter fabric fence shall have manufactured stitched loops for 2 inch x 2 inch post installation. Stitched loops shall be installed on the up hill side of the sloped area.
5. Filter fabric fences shall be removed when they have served their useful purpose, but not before the upslope area has been permanently protected and stabilized.
6. Filter fabric fences shall be inspected by applicant/contractor immediately after each rainfall and at least daily during prolonged rainfall. Any required repairs shall be made immediately.